TV distribution after 2034

Why it cannot be assumed that broadband will offer a universal solution for all of the UK

February 2024

Building a better working world

Contents

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Key messages

- Over 5.5mn UK premises (18%) are predicted to be without a high-speed broadband subscription in 2040, despite the government's commitment to 99% network coverage by 2030.
- Those forecast to be without high-speed broadband are disproportionally represented by vulnerable groups in society, such as the elderly, disabled and low-income households.
- It's crucial that government policy around TV distribution continues to reflect the needs of everyone in society, not just those with access to the fastest broadband networks.
- For TV distribution beyond 2034, a hybrid solution incorporating the existing DTT network is likely to remain the best outcome for all stakeholders, given the social equality impacts, complexities, costs, reliability concerns, and energy considerations of a full migration to IP distribution.
- Political certainty around the future of DTT will help incentivise the investments required to secure an on-going, universal service providing genuine choice to consumers.

The last decade has been a 'golden age' for television, with consumers enjoying an ever-growing array of high-quality content via a range of different platforms and devices, wherever they want, whenever they want, at home and on the go. Whilst linear broadcasts over Digital Terrestrial Television (DTT) remains the mainstay of UK television viewing, the rapid proliferation of both global and national streaming services, such as Netflix, Disney+, Prime Video, iPlayer, and ITVX has raised questions about the future of TV distribution.

In October 2023, Ofcom launched a call for evidence on the Future of TV Distribution, seeking evidence from industry stakeholders as to how the UK television market is expected to develop up to and beyond 2034, when the current DTT multiplex licences expire. A key question for government is whether, and to what extent, the UK's broadband network would be ready to act as the sole solution for universal TV distribution beyond 2034, were the DTT network to be switched-off.

In light of this, EY has examined the practicalities of relying on Internet Protocol (IP) for TV distribution considering the anticipated take-up of high-speed broadband by consumers, relevant trends in content viewing, and the pros and cons of alternative models for TV distribution. We conclude with a series of policy implications stemming from our study.

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Unequal consumer uptake of high-speed broadband

It is not just the headline speed that impacts on the reliability of internet video streams, but also factors such as latency, network congestion and Wi-Fi degradation. This is compounded by the ever-increasing array of connected devices and services that are putting increased strain on home internet connections, meaning that speeds of up to 60 Megabits per second (Mbps) are recommended by ISPs for customers seeking reliable, high-quality video.

Whilst the government's target is nationwide gigabit coverage by 2030, customers are still required to subscribe to the service, and it cannot be assumed that they will necessarily opt to take a sufficiently fast connection. Despite almost universal coverage of high-speed broadband today, with 96% of all premises covered, we find that 15% have a connection speed of less than 30 Mbps and a further 13% have no fixed broadband at all.

Furthermore, we find that these no – and slow – broadband households are distributed unequally across society. Using constituency-level data on broadband connections and a range of socio-demographic measures, we undertook an econometric analysis to determine the key factors affecting high-speed broadband take-up (download speeds of 30 Mbps+).

Our analysis finds that reduced levels of take-up are associated with more vulnerable populations, such as the elderly, those on lower incomes, and people with mental or physical disabilities. Geographically, we find that those constituencies tend to be in the nations and regions, such as Northern Ireland, Scotland, Wales, northern England, or Cornwall.

Our analysis also finds indications of reduced broadband take-up among younger populations (those aged 26 to 35 in 2022). Considering also the rapidly growing number of mobile subscriptions, this suggests that mobile devices may be being favoured by households with a limited need for high-speed internet. However, these mobile services cannot be presumed to be sufficient for universal TV over IP, given the associated costs and limitations of data usage on mobile networks. Whilst it is difficult to gauge how the consumption habits of this new generation of consumers will change as they grow older, it certainly casts doubt on the universality of fixed broadband take-up beyond 2034 and the ability of IP networks to underpin a universal TV service.

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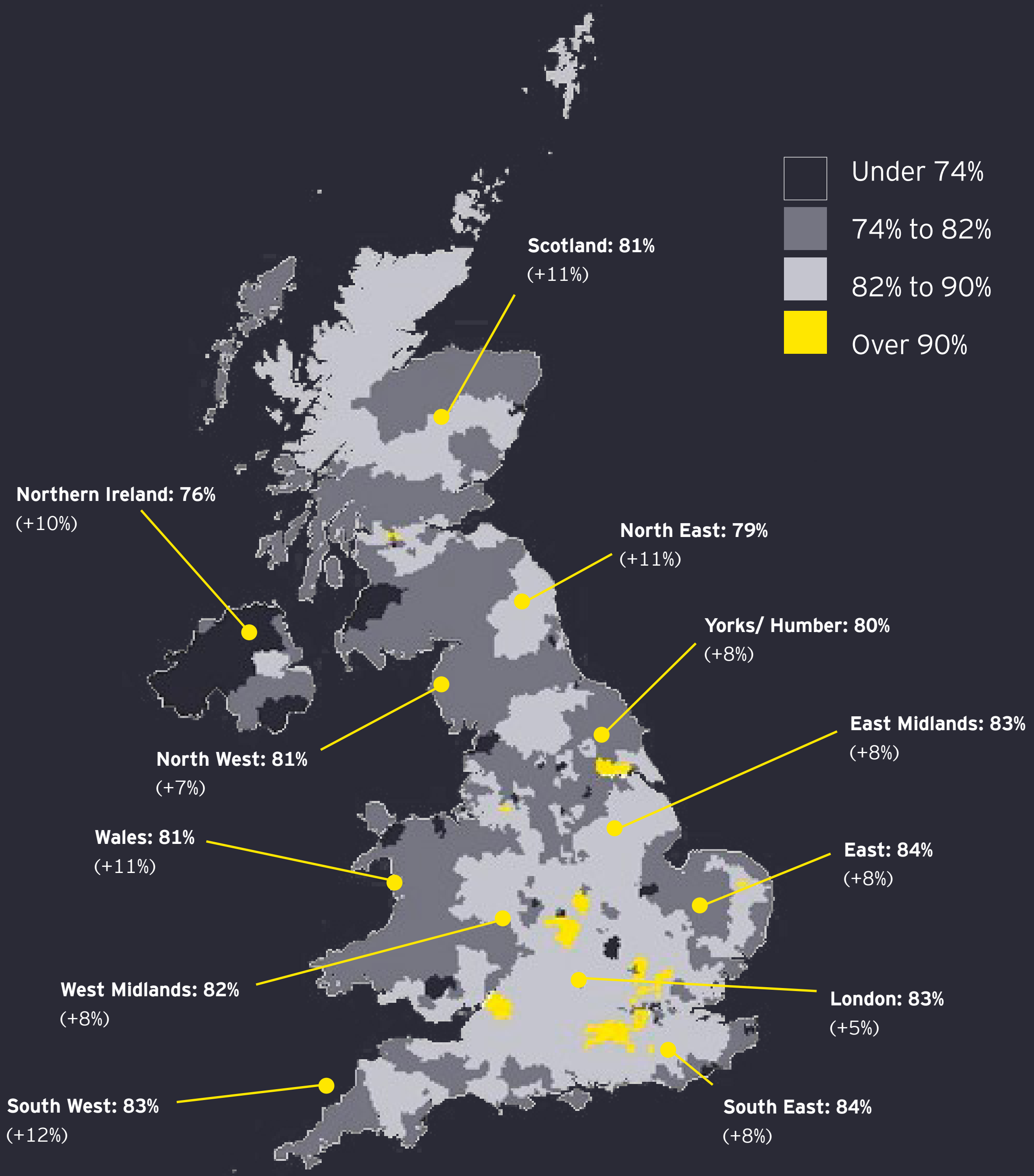
UK high-speed broadband take-up 2040



Average UK take-up in 2040 = **82%**

(+10 percentage points compared to 2022)

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Based on these findings, we forecast take-up rates of high-speed broadband in both 2035 and 2040. Our analysis predicts that 19% of all UK premises will be without high-speed broadband in 2035, rising to 38% in those constituencies with the lowest levels of take-up. Digging into the data, we find that these constituencies remain concentrated in the less densely populated areas of the UK, where consumers have median wages of up-to 30% less than the national average. Furthermore, we find this pattern is set to persist, with 18% of premises (over 5.5mn) still forecast to be without high-speed broadband when considering the market in 2040. Whilst broadband access itself is a key consideration for social mobility, these findings suggest that a move to IP distribution alone for TV would risk exacerbating the digital divide.

The risks associated with IP-only TV delivery outweigh the benefits

Observing how people currently watch TV, it is clear that linear broadcast over DTT remains the most popular way to watch, despite the growth of short-form mobile content (e.g., TikTok/YouTube), as well as streaming services (e.g., iPlayer, Netflix) providing catch-up and on-demand TV viewing. Whilst IP distribution can offer consumers a greater choice of content at higher video quality – including ultra-HD 4K and high-dynamic range (HDR) content – live TV still accounts for 44% of all video viewing, with 80% of that content viewed on a TV.

As it stands, the internet currently operates on a 'point-to-point' basis, with data packets being sent from a specific server to a single receiver. With this topology, 10mn people watching the same live sporting event via IP distribution would require 10mn unique connections, creating a large volume of traffic on the core transmission network that risks congestion and reliability issues for consumers. To help alleviate this issue, several alternative network topologies have been developed, including multicast and deep Content Delivery Network (CDN) models. Whilst these IP models help alleviate the issues associated with transmission capacity they are not without their challenges.

In a multicast model, data is transmitted on a 'one-to-many' basis, allowing many users to tap into the same stream of data from the server, drastically reducing the data requirement on the core transmission network. However, as multicast transmission requires a set of specific protocols, there are compatibility challenges to its mass adoption, requiring an additional layer of governance and coordination across ISPs and specific Customer Premises Equipment (CPE) costs for consumers. Furthermore, whilst this configuration helps with live-TV broadcasts, it does not allow for any improvement of service in on-demand viewing – which is necessarily point-to-point.

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For that, a deep CDN model continues to deliver data on a point-to-point basis but avoids congesting the core transmission network by hosting the content at the network edge, close to the end consumer. Whilst this improves quality and reliability for both linear and on-demand viewing, it also means that broadcasters must invest heavily in their CDN (or pay the costs of a virtual CDN) in order to host their content at roughly 1,000 different access nodes around the country.

In light of this, we find that the investment required to migrate all TV content to IP networks – along with the inherent inefficiency of configuring the network to cope with peak-time congestion – is likely to make an IP-only solution more costly for all stakeholders, whilst reducing the reliability, resilience, and universality of the TV distribution network.

A hybrid approach ensures live TV remains available to everyone

Overall, our study finds that a wholesale move to IP distribution as the sole solution for universal TV distribution would put a significant group of people at risk of being 'left behind' by 2040. The higher on-going costs associated with high-speed broadband services, as well as the added complexity of setting up the in-home devices needed for IP distribution, will mean that some consumers are unable to make the switch; particularly those with vulnerabilities, such as the elderly, people with physical or mental disabilities, or households on lower incomes.

> "We risk excluding those who live in rural areas, do not have an internet connection and an older generation that rely on being able to watch television in its traditional format.
>
> The Rt. Hon. Stephanie Peacock, MP
> Shadow Minister for Digital, Culture, Media & Sport

In contrast, an evolution of today's existing hybrid DTT and IP delivery model would mitigate the risks involved with IP-only delivery, whilst giving customers an increased choice of what, where and when to watch. In this respect, DTT and IP distribution offer clear complementarities, with each technology 'filling the gaps' of the other, to meet different customer needs. IP services can continue to offer consumers a wide variety of higher-definition content; whilst DTT has an equal – if not more important – role to play as the backbone for low-cost, reliable TV distribution, with the established network providing a universal coverage that can help 'take the strain' at times of peak demand.

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Consideration area	DTT	IP-only	Hybrid (DTT+IP)
Upgrade costs	◕	◑	◕
Customer costs	●	◑	◕
Energy efficiency	●	◑	◕
Quality and choice	◑	●	●
Reliability	●	◑	●
Certainty for broadcasters	●	◔	◕

Key:
Worse outcomes ← ○ ◔ ◑ ◕ ● → better outcomes

With policy makers now considering issues that will impact on the future of TV distribution in the UK, it is crucial that the differing needs of all consumer groups are well reflected in their policy outcomes. Considerable ambiguity remains around the future take-up of high-speed broadband, as well as the preferences TV viewers will have for what, where, when, and how they watch. This makes it all the more important that policy makers maintain both optionality and resilience in the broadcasting system, ensuring an on-going universal service that provides consumer with genuine choice, rather than trading certain costs for uncertain benefits.

The ongoing importance of the DTT network to a wide number of constituents is increasingly well recognised, with several MPs having called for greater commitments to maintain the existing DTT services well past 2034. Not only would these commitments protect the interests of constituents that rely on DTT broadcasts, the certainty that they provide will also help ensure the right level of investment can be made by the industry to sustain and improve the DTT network for the next generation of TV viewers across the UK.

1. Introduction

There is a growing use of catch-up and on-demand video services by viewers, leading some stakeholders to ask whether the entirety of the content currently delivered via DTT could be distributed over broadband as fibre networks become more widely available. However, despite these trends, DTT currently remains the most popular method of TV delivery with audiences, complemented by those over-the-top (OTT) services delivered via IP networks.

On 17 October, Ofcom published a call for evidence on the 'Future of TV Distribution' in which it invites stakeholders and viewers to "share evidence on the key factors that will affect audience and market outcomes to 2034 and beyond."

Against this backdrop, Arqiva asked EY to examine the practicality of relying on the UK's broadband network as the sole means of universal TV distribution beyond 2034, considering issues such as take-up of broadband, cost, efficiency, environmental concerns, and overall outcomes for consumers.

1.1 Scope of work

In this report, we address several key questions that policy makers must consider when thinking about the suitability and reliability of broadband as the universal TV distribution system:

- What is the anticipated take-up of high-speed broadband after 2034?
- How do the different models of IP TV delivery compare with each other in terms of cost, quality, and reliability, and with the existing DTT network?
- Which solution, or combination of solutions, is most likely to lead to the best outcomes for the full spectrum of UK viewers?

Along the way, we consider what is required in terms of high-speed broadband to ensure a reliable TV viewing experience; as well as considering 'who pays' for the network and what these factors mean for equality of distribution across the UK.

To forecast the anticipated take-up of high-speed broadband, we first undertake an evidence-based econometric analysis of real-world consumer behaviour, using publicly available socio-demographic data, before projecting our findings forward based on the anticipated development of the most relevant socio-demographic factors over time.

Whilst our study examines a number of financial, logistical, and socio-economic benefits from maintaining the existing DTT network as the basis for UK broadcasting beyond 2034, we do not dispute that continued investment in the UK's broadband network should also remain a priority for government and industry.

1.2 Structure of this report

The remainder of this report consists of three main parts:

- Section 2 assesses the likely adoption of high-speed broadband after 2034 using existing broadband take-up data, defining relationships between various factors with econometric modelling before forecasting this in 2035 and 2040.
- Section 3 outlines how changing consumer viewing habits have increased the amount of video content viewed over IP networks, before discussing the challenges in delivering TV over IP networks. We finish this section by outlining the benefits of a hybrid approach, with the DTT network supplemented by IP delivered on-demand services, considering the impact on consumers, broadcasters, energy consumption, reliability, and efficiency.
- Section 4 concludes with several key policy implications stemming from our study, highlighting the importance of securing affordable access to TV for everyone whilst maintaining choice and quality. Finally, we consider the impact the policy environment can have, highlighting the importance of political stability for future investment.

2. High-speed broadband take-up after 2034

The government's Universal Service Obligation (USO) for broadband will seek to ensure that all households and businesses in the UK are covered by (though not necessarily connected to) a broadband network by 2030.[1] Whilst the government defines 'decent broadband' as download speeds of at least 10 Mbps, the headline speed advertised for the broadband package often differs from the speed users actually experience, due to a range of technical factors.

Furthermore, whilst the availability of a broadband connection is expected to be largely universal, it does not mean that all customers will choose to adopt high-speed broadband. Current consumer trends show that there is a significant group of people that are not subscribers of high-speed broadband, despite having coverage in their region. Our analysis finds that lower rates of high-speed broadband adoption are associated with certain demographic characteristics, including vulnerabilities like older age, the prevalence of disabilities and low income.

Projecting these characteristics forward beyond 2034, we find that a substantial group of over 5.5 million premises (18%) will not necessarily choose to take (or be able to afford) a high-speed broadband subscription. As a result, any reduction in the DTT network and shift to IP distribution would risk reducing access to and/or increasing costs for television viewing for these people.

This section discusses the role of broadband take-up in determining the feasibility of IP-only distribution after 2034. We begin by setting out the broadband and bandwidth requirements for IP distribution, concluding that it is likely to require high-speed broadband of at least 30 Mbps. We then undertake an econometric modelling exercise to determine the extent to which the UK population will adopt high-speed broadband after 2034, to identify those groups in society who will be most significantly affected by a complete shift to IP services.

2.1 What is needed for effective IP delivery?

Digital TV content may be delivered through DTT or IP distribution. Unlike traditional DTT services, which rely on antennas to receive signals, IP distribution operates by streaming video content through the internet and includes IPTV or the increasingly popular OTT services like Netflix and Amazon Prime Video. IPTV delivers high-quality video content including live TV channels through specialised network infrastructure and equipment like set-top boxes or TVs with built-in IPTV apps, whilst OTT services use the public internet to deliver content directly to network connected devices, typically streaming content on-demand. Industry views on the recommended download speeds for video streaming range from 25 Mbps to 60 Mbps as outlined in Table 1 overleaf.

1 https://commonslibrary.parliament.uk/research-briefings/cbp-8146/.

Table 1:

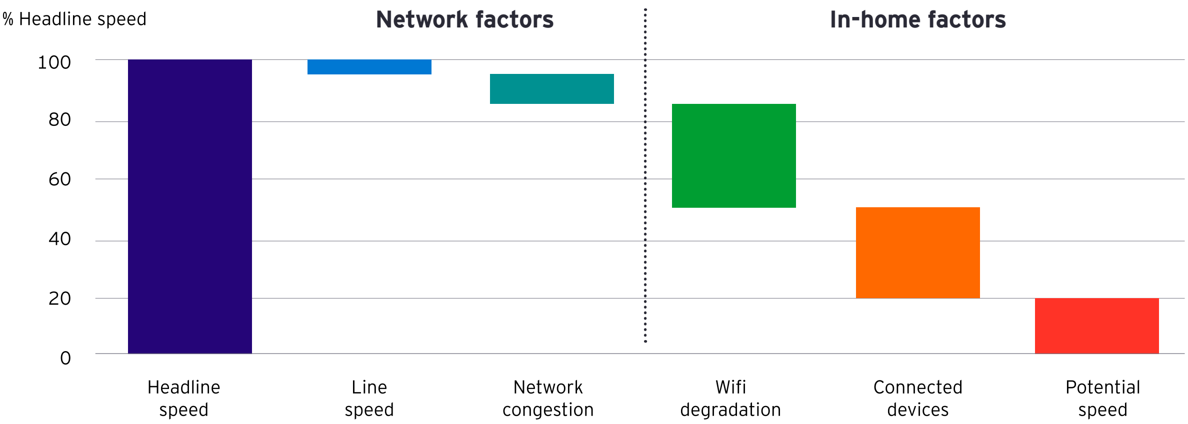
Broadband speed requirements for video

Stakeholder	Recommended minimum speed
Vodafone	60 Mbps[2]
Cable.co.uk	50 Mbps[3]
Virgin	30 Mbps[4]
Sky	25 Mbps[5]

Similarly, Ofcom's 2023 Home Broadband Performance report shows that connections slower than 36 Mbps cannot reliably deliver UHD Netflix streams (and in some cases struggle with HD streams), with 26% of streams failing to be delivered in UHD below this speed in 2022;[6] whilst the Rural Services Network argues that the current Universal Service Obligation, at 10 Mbps, is out-of-date and "should be upgraded to superfast broadband downloads speeds of 25 to 30 Mbps minimum."[7] This is also reflected in consumer guidance for broadband speeds required to stream video content, with each device in the home requiring accessible bandwidth of 5-8 Mbps for High-definition (HD) and at least 25 Mbps for Ultra High-Definition (UHD).[8]

Importantly, consumers will typically have multiple competing demands on their home broadband at any one time. This means that broadband packages with higher speeds are likely to be needed to ensure a reliable video streaming connection as the final speed available to users for streaming TV may be considerably lower than the headline speed of the broadband subscription service. A stylised example of how several factors dampen the headline speed is set out in the Figure 1 below:

Figure 1 Example – Factors impacting advertised broadband speed



Source: EY analysis

2 Click **here**.
3 Click **here**.
4 Click **here**.
5 Click **here**.
6 Click **here**.
7 Click **here**.
8 Click **here**.

As Figure 1 shows, a range of factors both in the network as well as within the home that can erode the speed delivered to the device by up to 80% compared with the headline speeds advertised. These factors combined can detrimentally impact the viewer experience, reducing the quality of the video stream among other interruptions like buffering and jittering.[9]

- **Actual speed:** The actual speed received by customers can vary from the advertised headline speed, meaning customers do not always receive the full service they subscribe to. Ofcom's Broadband Speeds Code of Practice requires providers to inform customers at the point of sale as to what guaranteed speed they will have on their broadband service.[10]
- **Network congestion:** During busy times the speed of the service will reduce due to bandwidth availability on the customer's network node. Where the total demand on any particular node exceeds the available capacity, speed and performance will be impacted. Ofcom's home broadband performance report states that peak-time download speeds averaged between 94.7% and 96.3% of average maximum speeds for 36-38 Mbps services. Further, for services between 30–50 Mbps, c.50% customers received speeds of less than 90% of the maximum, and a small proportion of customers received less than 60% of their maximum speed.
- **Wi-Fi degradation:** Ookla's test results show the average Wi-Fi user's experience is generally 30%-40% of the speed available through an ethernet cable, due to wireless interference from devices such as a microwave and cordless phones as the signal travels through the air.[11] Many customers prefer a Wi-Fi-enabled device to provide flexibility, and in some cases customers don't have a choice where IP devices don't have a wired option (i.e., Amazon Firestick and Google Chromecast).
- **Connected devices:** The higher the number of connected devices in the household, the lower the bandwidth available for streaming TV. UK adult internet users spend an average of 3 hours 37 minutes a day online on computers, tablets, and smartphones,[12] and are increasingly reliant on the internet for a host of activities, including email, social media, remote working, and the use of internet-connected devices like thermostats and smart speakers. As a result, there are an estimated nine connected devices per household on average,[13] whilst the growing range of use cases suggests future bandwidth requirements in a household are set to increase.

A key characteristic of IP services is the ability to offer customers content in higher quality, with a recent survey revealing that 56% of video streaming viewers prefer higher resolutions such as UHD. However, high-quality video streaming requires a stable internet connection to provide a continuous service to the end user.

9 https://www.broadbandgenie.co.uk/broadband/help/stop-buffering.
10 https://www.ofcom.org.uk/data/assets/pdf_file/0016/244321/2022-Voluntary-Code-of-Practice-Residential.pdf.
11 https://www.ookla.com/articles/improve-wi-fi-in-the-home-q1-2023.
12 https://www.ofcom.org.uk/__data/assets/pdf_file/0013/220414/online-nation-2021-report.pdf.
13 https://publications.parliament.uk/pa/cm5803/cmselect/cmcumeds/157/report.html.

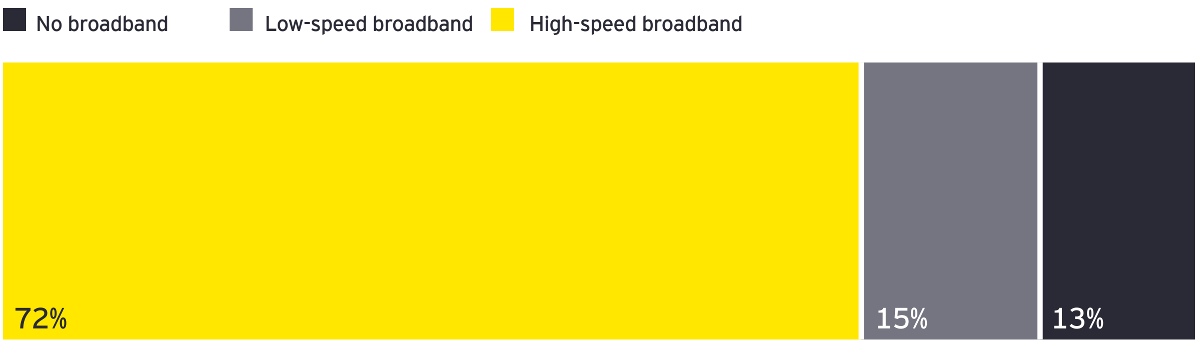
Data transferred over IP networks are split up into a series ‘packets’ that are recombined by the receiver to complete the information being transmitted. This is not typically a problem when browsing the internet or downloading files, as the Transmission Control Protocol (TCP) that manages these data transfers can request that any packets ‘lost’ because of network issues be resent. Whilst the slight delay this causes is largely imperceptible when loading a webpage, it can lead to significant quality issues for live TV. Increasing the broadband speed is one of the most effective ways of helping reduce packet loss to ensure a quality output.

We therefore define “high-speed broadband” as the speed needed to reliably stream live TV without buffering or other issues, assuming this to be 30 Mbps or more. This represents a level that would ensure a reliable TV service for consumers in a ‘real world’ setting, with multiple simultaneous demands on their home broadband (e.g., multiple TVs, online gaming).

2.2 Consumer adoption of high-speed broadband today

Whilst coverage of high-speed broadband across the UK is high at 96%,[14] take-up is considerably lower at 72% as seen in Figure 2 below.[15] Using data sourced from Ofcom’s Connected Nations Report, we find that 15% of premises in the UK have a low-speed connection (under 30 Mbps), and 13% are not fixed broadband subscribers at all. It is likely that these individuals will not be able to access or struggle to stream live TV without issues in the absence of DTT services. This suggests there is a large gap in adoption to be bridged if IP networks are to be the only channel for TV distribution for households across the UK post 2034.

Figure 2: Broadband take-up across the UK (2022)[16]



Source: EY analysis using Ofcom data

14 https://www.ofcom.org.uk/__data/assets/pdf_file/0031/237865/spring-2022-connected-nations-update.pdf.

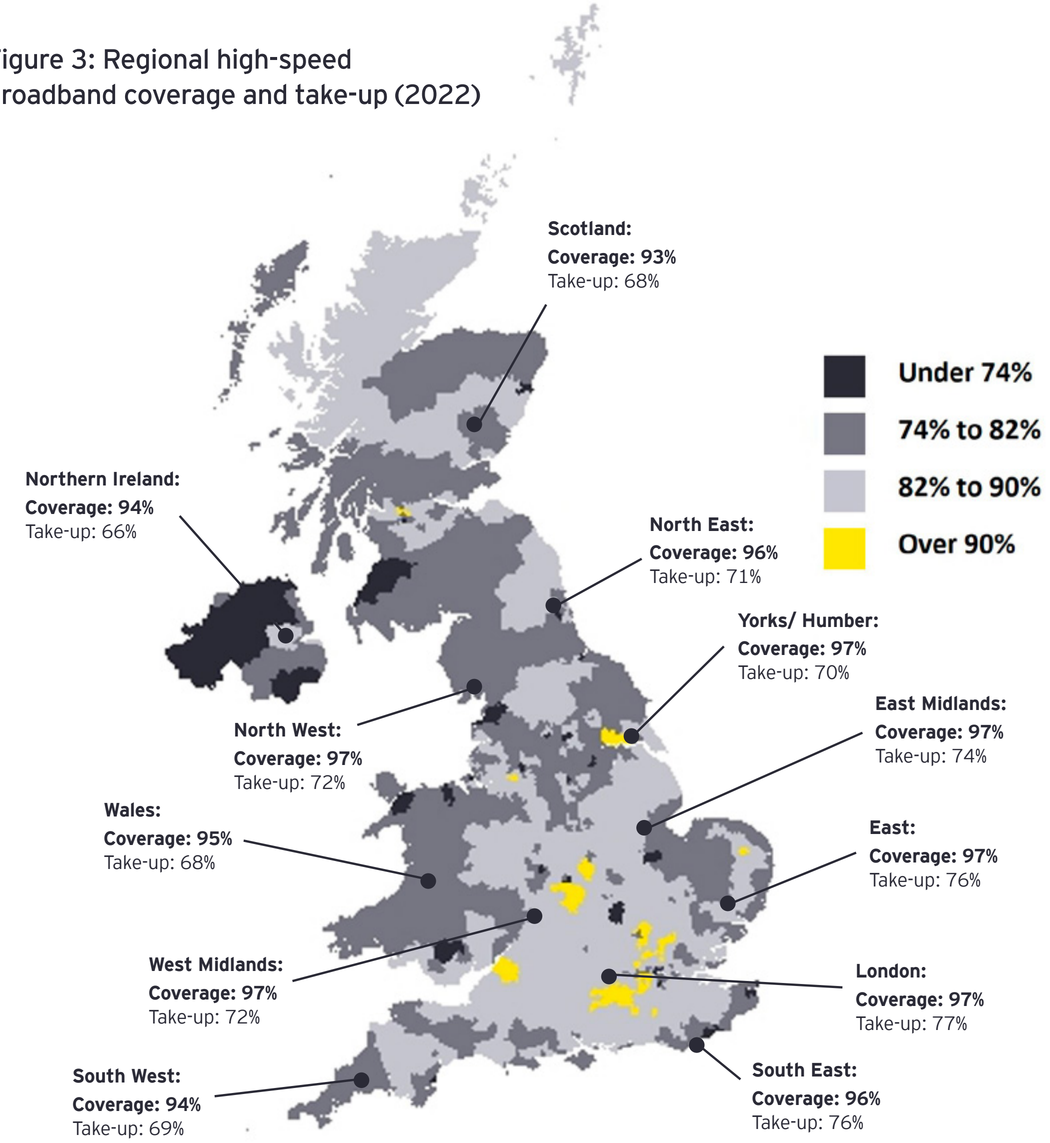
15 Take-up is defined as the total number of connections at a given speed divided by the total number of premises (both residential and commercial).

16 Seven constituencies were identified as anomalies due to broadband take-up exceeding 100% and have been excluded from this chart.

Analysing this data at a constituency-level, we find significant geographical variation in high-speed broadband take-up rates across the UK. At present high-speed broadband take-up ranges from 42% in constituencies with the lowest adoption to a high of 88%. This also adds further evidence to the persistence of a 'digital divide' within the UK, with Figure 3 showing that the northern and western regions of the country having more limited adoption of high-speed broadband than the southeast.

Importantly, this digital divide is not due only to variations in coverage, but also variations in take-up between the different regions of the UK. Whilst Northern Ireland has the lowest high-speed take-up at 66% followed by Wales and Scotland at 68%, London has a far higher level of take-up at 77%. This aligns with Ofcom's finding that 58% of the 1.5 million premises in 2020 lacking high-speed broadband connections were in rural areas.[17]

Figure 3: Regional high-speed broadband coverage and take-up (2022)



	Coverage	Take-up
UK Average	96%	72%

17 https://commonslibrary.parliament.uk/research-briefings/sn06643/.

2.3 What drives high-speed broadband take-up?

Ofcom's 2022 Digital Exclusion Review sets out some of the key issues and barriers to internet adoption, including:

- **Access:** a small proportion of households cannot access an adequate internet connection due to lack of coverage of high-speed broadband.
- **Affordability:** according to the ONS, three in 10 households struggled to pay their communications bills in January 2023.[18]
- **Ability:** those who lack the digital skills and/or confidence to navigate the online environment.

For access, less than 1% of customers do not have access to any type of broadband, whilst c.12% of households do not subscribe to a fixed broadband connection. Therefore, affordability and ability are expected to be the biggest blockers to fixed internet adoption, with the excluded groups of people typically being the most vulnerable in society, namely:

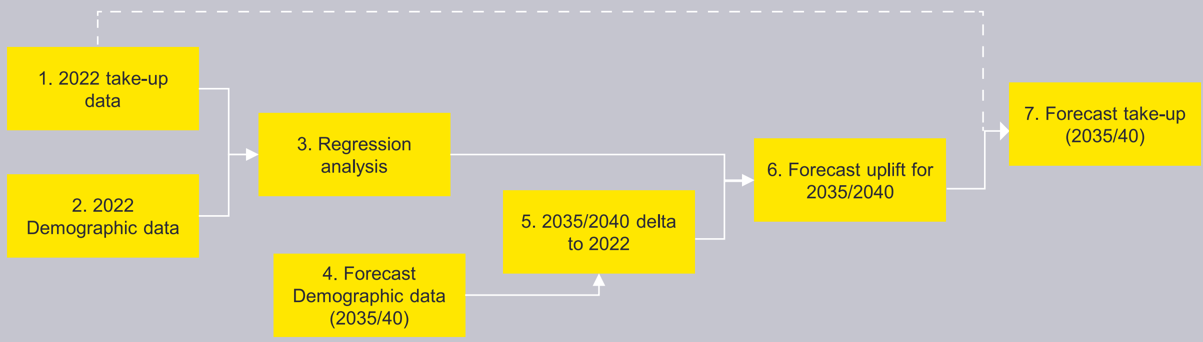
- The elderly (+65)
- People with disabilities
- Low-income households.

To better determine the extent to which these vulnerability factors affect the take-up of high-speed broadband, we undertook a detailed econometric analysis based on fixed broadband data collected from Ofcom's Connected Nations dataset for 650 UK constituencies. This includes parameters like the total number of premises in each constituency, the number of premises which have coverage at each speed, and the number of active connections by speed. This was combined with demographic data sourced from the Office for National Statistics (ONS) and the National Records of Scotland that include variables such as population by age, prevalence of disabilities, employment statistics, and median wage. Our analytical approach is outlined in Box 1 below.

18 https://www.ofcom.org.uk/__data/assets/pdf_file/0020/260147/2023-april-affordability-of-communications-services.pdf.

Box 1: Overview of our econometric approach

A high-level view of the regression analysis used to identify the impact of each of the variables on the take-up of high-speed broadband in 2035 and 2040 is set out below (see Appendix A for further details).



Step 1: Calculate high-speed broadband take-up in 2022 for each constituency using Ofcom's connected nations datasets.[19]

Step 2: Combine this with demographic data on a range of factors such as age, wages, employment status and disability levels, collected for each constituency in the UK.

Step 3: Perform regression analysis to establish the relationship between high-speed broadband take-up and each demographic variable today (see Figure 3). Test the demographic variables for statistical significance and refine the analysis, before selecting the most relevant variables to include in the final regression. This gives the equation:

High-speed broadband take-up

$$
\begin{aligned}
&= -0.24 + (1.05) \times coverage + (-0.75) \times Non\ residential\ premises \\
&+ (-0.25) \times Age26to35 + (0.79) \times Age56to65 + (-0.40) \times Ageover65 \\
&+ (0.01) \times Median\ wage + (-0.46) Disability + (-0.01) \times Scotland + (0.00) \\
&\times Wales + (0.01) \times NorthernIreland
\end{aligned}
$$

Step 4: Forecast demographic input data for both 2035 and 2040 (see Table 3 below).

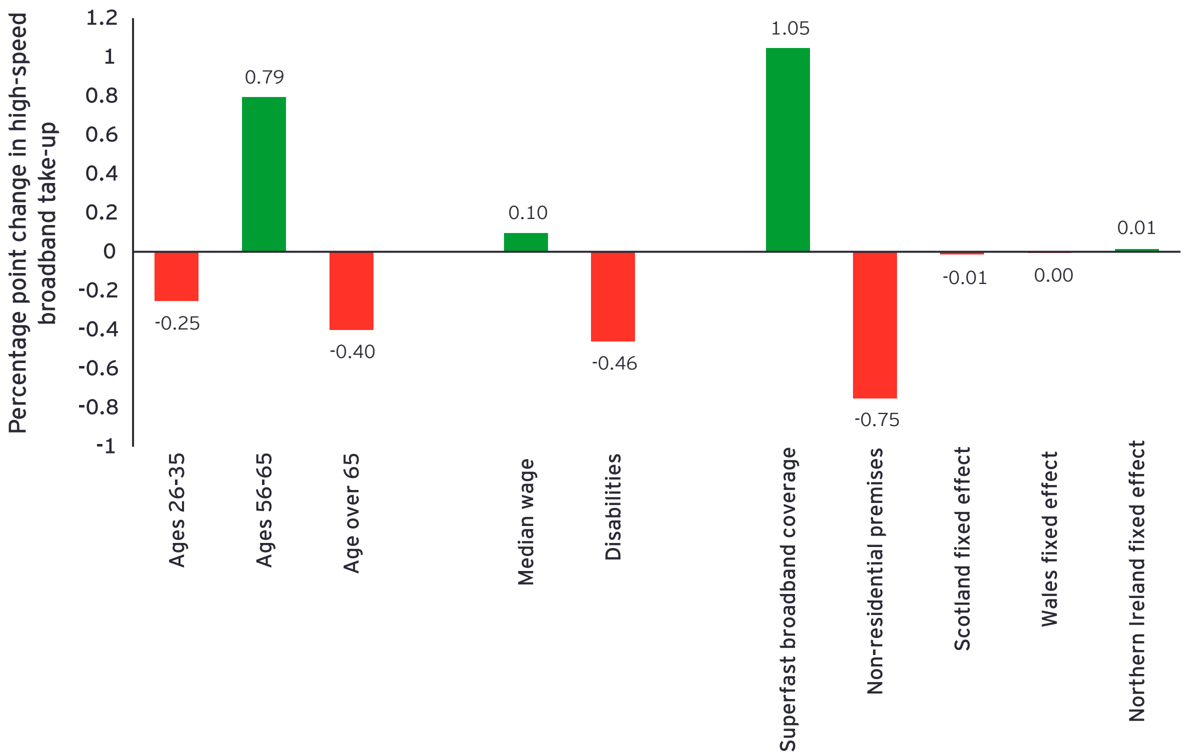
Step 5: Calculate delta between forecast demographic data for 2035/40 and 2022 actual data.

Step 6: Apply the 'elasticities' estimated by the regression equation to the forecast demographic deltas from Step 5 to produce the anticipated uplift in take-up for each constituency by 2035/40.

Step 7: Appy the estimated uplifts from Step 6 to 2022 high-speed broadband up-take for constituency to produce both 2035 and 2040 take-up forecasts.

19 High-speed broadband take-up defined as total active broadband connections over 30 Mbps divided by total premises in each constituency.

Figure 4: Factors influencing high-speed broadband take up



	Age			Vulnerabilities		Controls				
Coefficients	-0.25	0.79	-0.40	0.10	-0.46	1.05	-0.75	-0.01	0.00	0.01
Significance	*	***	***	***	***	***	***	*		

Key: (***) Over 99.9% significant, (*) 99% significance, ( ) Not significant

Our findings from the regression analysis are summarised in Figure 4 above. The values shown can be interpreted as consumer demand "elasticities", meaning they show the percentage point change in the proportion of premises that take-up high-speed broadband for each percentage point change in the explanatory variables. For example, if a constituency has a onepercentage point greater share of population aged 56 to 65, it is expected to have a 0.7982 percentage point effect (on average) on the observed take-up of high-speed broadband compared to other constituencies.

Coverage is found to be a highly significant factor driving take-up, with a one percentage point increase in the coverage of high-speed broadband leading to a 1.0510 percentage point change in the proportion of premises in the constituency that adopt high-speed broadband. Given that the UK average coverage of high-speed broadband is already at 96%, we do not expect it to significantly affect adoption rates in future years.

However, we also find a positive – though smaller – impact on high-speed broadband take-up from median wage in a constituency (as a percentage of UK average median wage). As wage is positively correlated with improved affordability it is likely to boost high-speed broadband take-up. Inversely, this means that lower adoption of high-speed broadband is associated with lower wages.

This is supported by additional evidence of affordability negatively impacting the number of broadband subscriptions (averaging £26.90 per month and £322.80 annually) with these user groups, further exacerbated by the cost-of-living crisis.[20] Ofcom estimates as many as two million households in the UK have affordability issues and are at risk of having to modify or cancel their subscription. Further, it has been suggested that one million households cut back or cancelled their internet package due to affordability issues in the 12 months to June 2023.[21] The issue of affordability is further intensified when considering the adoption of high-speed broadband required for IP services, since broadband subscriptions with speeds between 30-60 Mbps are 28% more expensive on average than connections under 30 Mbps.[22]

Our statistical analysis also substantiates the adverse impact of other vulnerability factors on high-speed broadband take-up, in particular older age, and the prevalence of disabilities. We find that a one percentage point increase in the proportion of population aged over 65 is associated with a 0.39 percentage point decrease in the high-speed broadband take-up. Disabilities has a similar impact with a one percentage point increase in the proportion of disabled people having a 0.47 percentage point decrease on high-speed take-up.

Our findings align with evidence citing that both the elderly and people with disabilities may lack the skills or confidence to use the internet. For example, 8% of people aged 65-74 and 26% of people aged 75+ do not have internet access at home.[23] Additionally, individuals with disabilities are found to be twice as likely to lack the basic digital skills needed to navigate life online, and account for a disproportionately low number of internet users.[24]

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20 https://www.uswitch.com/broadband/studies/broadband-statistics/.

21 **Digital exclusion (parliament.uk)**.

22 https://www.uswitch.com/broadband/studies/broadband-statistics/.

23 https://www.ofcom.org.uk/__data/assets/pdf_file/0022/234364/digital-exclusion-review-2022.pdf.

24 https://committees.parliament.uk/publications/40662/documents/198365/default/

Conversely, a greater number of people aged 55-65 years in a constituency is associated with increased take-up of high-speed broadband which may, for example, be due to an increased prevalence of families with multiple internet-user in the household.

Finally, the negative coefficient on the population aged 26-35 correlates with the growing trend of households using their mobile device as the sole form of internet access, foregoing a fixed internet connection. The number of mobile subscriptions in the UK has grown rapidly, doubling from 43 million in 2000 to 83 million in 2022, and further growth in mobile-only users could be a limiting factor in the take-up of broadband by 2040.[25] This effect, coupled with lower broadband take-up from the elderly, raises a question of whether we have reached 'peak fixed broadband' in the UK at c.87% take-up, noting that 2022 fixed internet penetration was slightly lower than in 2021.

2.4 High-speed broadband take-up after 2034

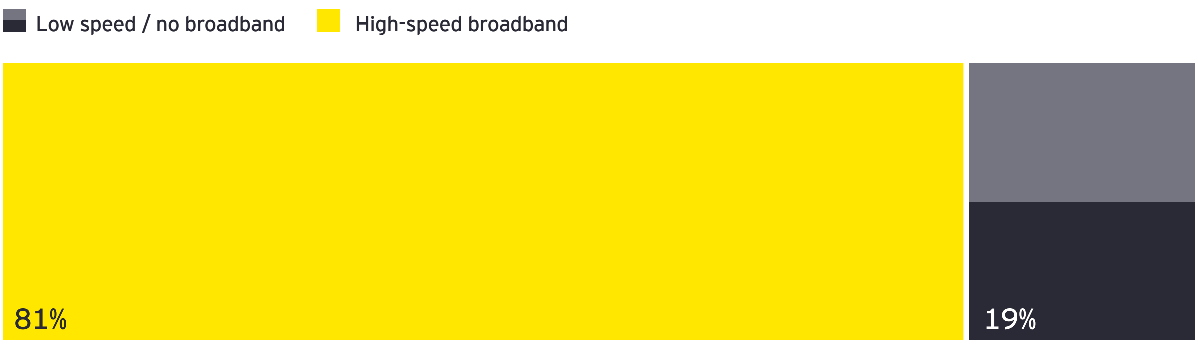
We use the parameters from our regression analysis together with forecasts on demographic changes to calculate the take-up of high-speed broadband in the UK in 2035 and 2040. The assumptions for the demographic forecasts are listed in Table 3 below.

Table 3: Assumptions for forecasts of demographic characteristics

Factor	Assumption for forecast
Coverage of high-speed broadband	Total broadband coverage in 2022 is greater than 99%, so all existing lines assumed to be high-speed by 2035.
% non-residential premises	Assumes no change from 2022.
Age (26 to 35 years)	Proportion of population in each age cohort forecasted using ONS death rates, and a constant birth rate.
Age (56 to 65 years)	
Age (over 65 years)	
Median wage	2022 median wage for each constituency inflated using the 5 year CAGR in annual pay for each region.
Prevalence of disabilities	Assumed no change from 2022.
Proportion of working households	Adjusted based on the latest UK average unemployment forecast published by the Office of Budgetary Responsibility (OBR) for 2028.

Given the demographic forecasts and regression coefficients, our modelling suggests the UK average take-up of high-speed broadband will grow to 81% in 2035 and 82% by 2040.

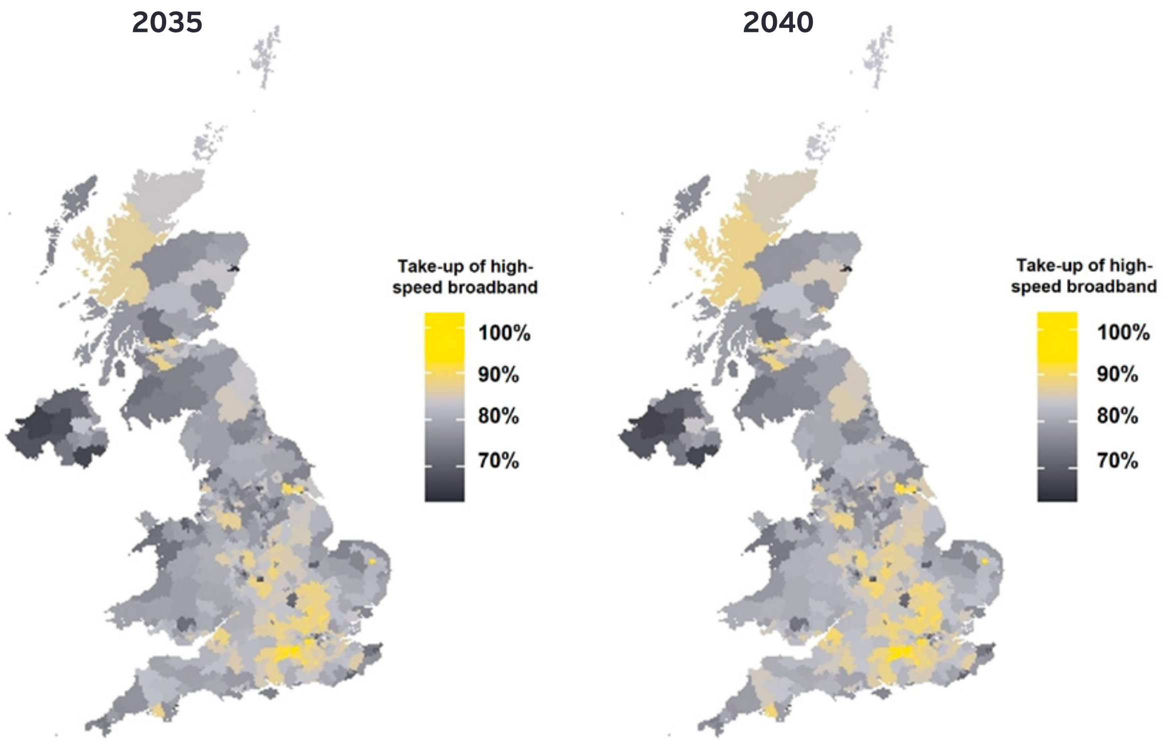
Figure 5: Forecast broadband take-up across the UK (2035)



25 https://www.uswitch.com/mobiles/studies/mobile-statistics/.

All constituencies are forecast to experience an increase in the rate of high-speed broadband take-up by 2035/40 whilst the variation across constituencies is expected to narrow, with the lowest take-up in a constituency predicted to be 63% and the highest 95% by 2040.[26] However, although the UK take-up of high-speed broadband is calculated to be 81% in 2040, 301 constituencies will still have adoption rates below this, with a geographic analysis revealing that digital exclusion will continue to be more pronounced for those constituencies towards the peripheries of the country (see Figure 6).

Figure 6: Predicted take-up of high-speed broadband by constituency



UK take-up: 81% **UK take-up: 82%**

Table 4 aggregates our constituency analysis to the regional level, again showing that the increased take-up between 2022 and 2040 is not spread uniformly across the UK, reflecting both changes to coverage and demographics over this period.[27] Whilst Northern Ireland remains the region with lowest take-up of high-speed broadband in 2040 at 76%, the Southeast is the highest at 84%. Wales and Scotland – both lower than any English region in 2022 – are forecast to have a higher take-up than both Yorkshire and The Humber and the Northeast in 2040; whilst the Southwest is forecast to have the highest increase in take-up driven in a large part by its greater coverage of high-speed broadband.

26 This excludes 7 constituencies that were considered data anomalies, for instance because take-up was greater than 100%.

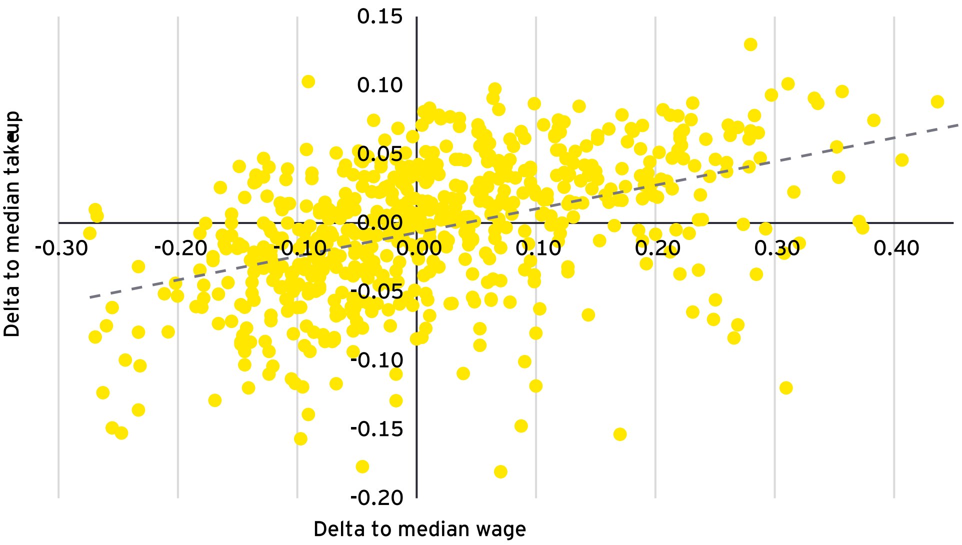
27 Constituencies that were identified as anomalies due to issues with the data set (for instance, where take up was over 100%) have been excluded.

Table 4: Regional high-speed broadband take-up (actual and forecast)

Region	2022 Actual	2035 Forecast	2040 Forecast
Northern Ireland	66%	75%	75%
Wales	68%	79%	79%
Scotland	68%	80%	80%
Southwest	69%	81%	81%
Yorkshire and The Humber	70%	78%	78%
Northeast	71%	78%	78%
Northwest	72%	80%	80%
West Midlands	72%	80%	80%
East Midlands	74%	82%	82%
East	76%	83%	83%
Southeast	76%	83%	83%
London	77%	82%	82%
UK	**72%**	**81%**	**81%**

We also expect significant variation in the distribution of high-speed broadband by socio-economic group in 2040. Figure 7 plots the forecast delta between each constituency's take-up and the UK median take-up, against the forecast delta between that constituency's median wage and the UK median wage. The range of c.30% between the highest (95%) and lowest (63%) take-up can be seen on the vertical axis; whilst the chart also clearly shows that higher take-up is associated with higher-income constituencies (shown on the horizontal axis).

Figure 7: Take-up variation by median wage (2040)



2.5 Conclusions on take-up

Although, the government has set a target for gigabit-broadband to be available to at least 99% of the country by 2030, this target only means customers having access to a service should they wish to subscribe to one. Based on our analysis of consumer behaviour today, and forecast changes to the demographic characteristics by 2035/40, we anticipate that actual take-up of high-speed services will remain lower than the government's target coverage allows.

Drawing insights from Ofcom data and present-day trends in the take-up of high-speed broadband, we find that a notable proportion of the UK population (28%) either have no broadband or a low-speed connection as of 2022. Our analysis considers the key demographic factors influencing the adoption of high-speed broadband, which include age, employment, income, and the prevalence of disabilities. Combining the outputs of the regression analysis with forecasts for demographic variables, we find that overall take-up of high-speed broadband is expected to increase to 81% across the UK by 2035 before rising slightly to 82% in 2040. However, this means that around 20% of premises will remain without high-speed broadband after 2034, with internet connections that are likely to be insufficient to reliably view high-quality live TV online.

Whilst younger customers are increasingly relying on mobile services in place of fixed broadband, these are not necessarily substitutes as there is considerable doubt as to these services' ability to support live TV streaming for a household. Assuming a household watches the average amount of live TV in HD, it would require over 100GB of data which is considerably higher than an average user of 5.6GB per month.[28] In fact, according to Ofcom in its Digital Exclusion Review, mobile-only households are likely to be 'narrow' internet users (low data usage) as they use the internet for only a small number of tasks.[29] Further, mobile-only households include those with affordability issues, with 31% of mobile-only users part of the most financially vulnerable groups, and thus unlikely to purchase the more expensive data-heavy usage subscriptions.

Furthermore, our analysis suggests that the imbalances currently seen in broadband adoption will persist in the future, with take-up of high-speed broadband in rural regions expected to be lower than the average. Looking at specific vulnerability factors associated with broadband take-up, we find that the elderly, people with disabilities and households on lower incomes likely to be the most disadvantaged if policy makers were to rely on universal high-speed broadband as the future of live TV distribution.

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28 **How much data do I need? Is 1GB, 4GB, 8GB, 20GB, 50GB ... enough data? (3g.co.uk)**.

29 Digital exclusion: a review of Ofcom's research on digital exclusion among adults in the UK.

3. TV distribution in the UK

Consumer habits around video consumption have undergone significant changes over recent years, driven by advancements in technology and the proliferation of new digital platforms. The amount of video content viewed over the internet has increased significantly, with the use of on-demand and OTT services doubling in the past five years.

This has put increased pressure on the UK's broadband networks, and whilst emerging technologies (such as multicast) offer some improvements to online video distribution, challenges remain for the widespread distribution of high-quality, reliable live-TV over the internet.

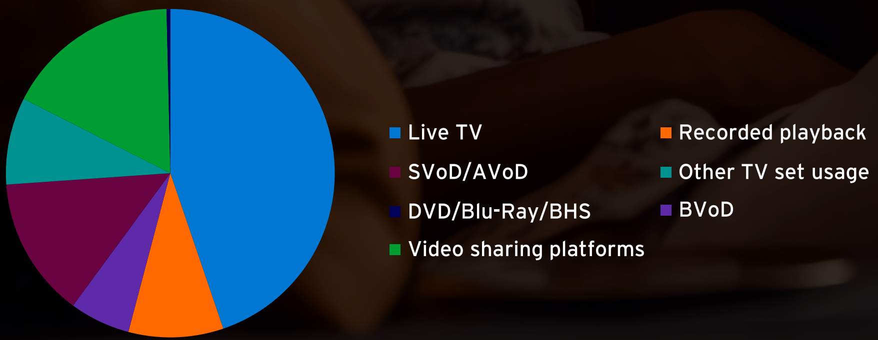
In contrast, we find that a hybrid approach – combining the DTT network with deep CDNs – offers consumers a greater choice of content at a time and quality of their choosing, whilst protecting the universal distribution of live TV offered free at the point of consumption.

3.1 How consumers are watching today

TV and video content remains an important part of British life. On average, individuals in the UK spend 4 hours 28 minutes a day watching videos across all devices; whilst live TV remains the most prominent form of consumption (44% of all video viewed across the country), with the average individual in the UK spending around 2 hours each day viewing live broadcast TV.[30]

However, the ways in which content is viewed are changing, with on-demand services including broadcaster on-demand (BVoD), subscription on-demand (SVoD) and video sharing platforms (such as TikTok and YouTube) becoming increasingly popular (see Figure 8). Nonetheless, despite an increasing choice of devices and formats (including a growing popularity of short-form content) that consumers can watch, 80% of video is still viewed via the TV.[31]

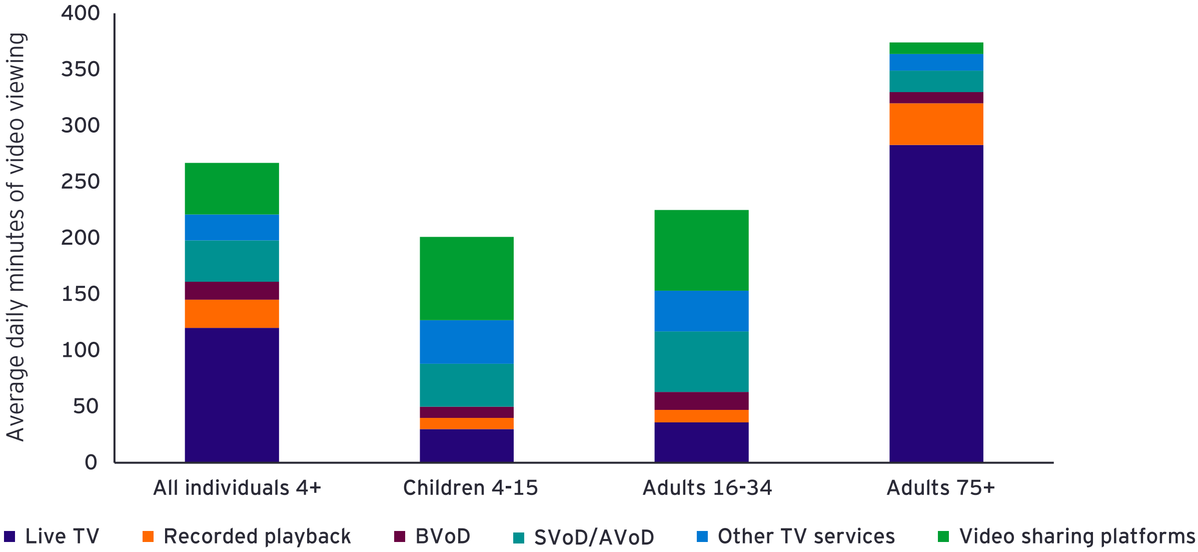
Figure 8: Proportion of video viewing across all devices, 2022[32]



30 https://www.ofcom.org.uk/__data/assets/pdf_file/0029/265376/media-nations-report-2023.pdf.
31 https://www.barb.co.uk/insight-parent/insight-what-people-watch/what-people-watch-sharing-video-is-caring/.
32 https://www.ofcom.org.uk/__data/assets/pdf_file/0029/265376/media-nations-report-2023.pdf.

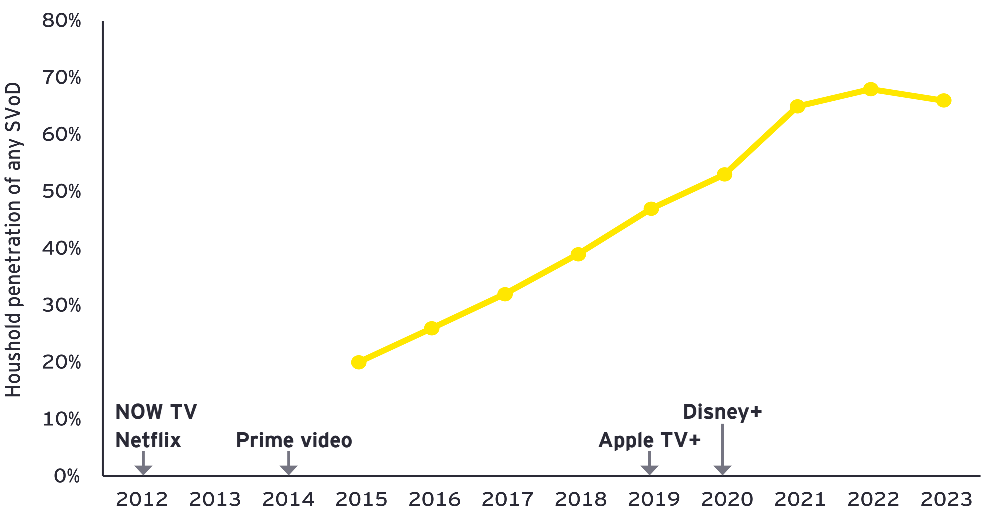
Unsurprisingly, behaviours across different age groups vary greatly (see Figure 9), with adults aged over 75 preferring to watch live TV content (c.80% total viewing); whilst adults aged 16-34 are more varied in their content consumption, opting to consume more video via sharing platforms (YouTube, TikTok) and SVoD (Netflix, Amazon Prime, Disney+).[33]

Figure 9: Total video viewing per person per day by age, 2022



Two-thirds of UK households accessed some form of SVoD service in 2022 and BVoD viewing now makes up 10% of broadcaster viewing, however there are signs that growth of these services is slowing. Figure 9 shows the household penetration of SVoD services in the UK together with launch dates of the largest providers.[34] Following a rapid increase in SVoD take-up between 2015 and 2021, we see a notable slow-down in 2022, followed by a slight reduction in 2023. With most major studios having now released an SVoD service, this suggests consumer adoption is plateauing.

Figure 10: SVoD household penetration and service launches



33 https://www.ofcom.org.uk/__data/assets/pdf_file/0029/265376/media-nations-report-2023.pdf.
34 Ofcom (2023) "Media Nations: UK 2023". Available at https://www.ofcom.org.uk/__data/assets/pdf_file/0029/265376/media-nations-report-2023.pdf.

3.2 Challenges to broadcasting TV over IP

These changes in consumer preferences have placed increased demands on the broadband network, with video accounting for an estimated 65% of all internet traffic in 2022.[35] This has highlighted several key challenges for broadcasting over IP networks, including congestion issues, customer costs and energy efficiency concerns. We explore each of these in more detail below.

3.2.1 Network congestion and upgrade costs

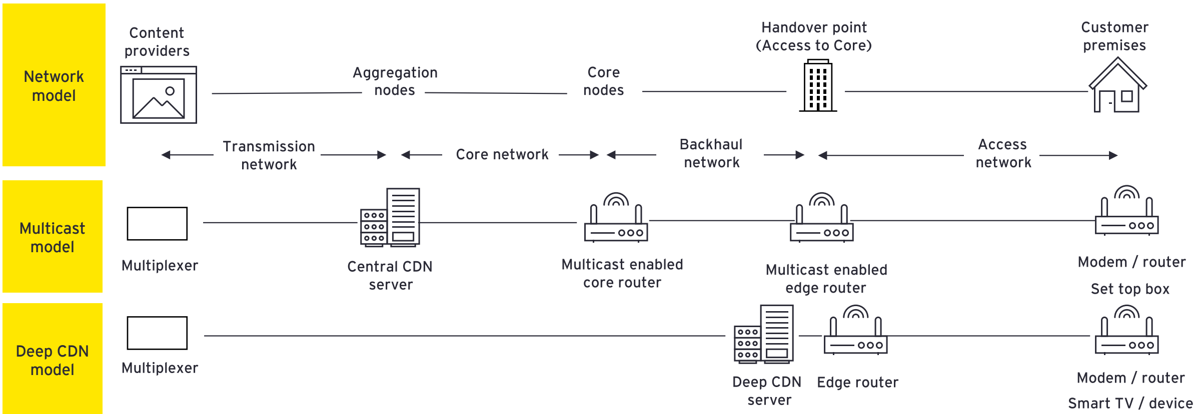
A typical IP network operates on a point-to-point basis, with a single sender transmitting data to a single receiver upon their request (e.g., to view a webpage, collect an email, or download a file). However, when it comes to live TV streaming, this means that 10 million viewers watching the same live event would require 10 million unique video streams – one for each user.

Those 10 million simultaneous HD video streams (at 8 Mbps each) would require an additional 80 Terabits per second (Tbps) of bandwidth across the network. To address this, Several different models have emerged to ensure content delivery is both cost-effective and reliable as data requirements on the internet grow, including:

- Multicast
- Deep CDNs (Content Distribution Networks)

These alternative TV delivery models take different approaches to mitigating the risk of congestion on the core and backhaul networks (see Figure 11), with different implications and challenges for network operators, broadcasters, and consumers.

Figure 11: Alternative IP distribution models



35 https://www.digitalinformationworld.com/2023/01/video-accounts-for-65-of-all-internet.html.

A typical telecoms network is a hierarchical structure of sub-networks, with a high capacity 'transmission network' being connected to a series of nodes by a 'core network'. These nodes are then connected to multiple handover points by a 'backhaul network', each of which connects to a number of customer premises via an 'access network'. The core network consists of a small number of high-capacity routers (c.50 for national coverage) that determine where to send data based on the customer's IP address. The handover point links the core and access networks and is typically where the network operator 'hands over' the sending and receiving of data to the customer's Internet Service Provider (ISP). The access network then delivers the data to the end customer, with a typical national IP network consisting of c.1,000 nodes.

Under a multicast model, content is delivered to the main aggregation nodes of the network before being 'cast' to multiple customers as a single stream of data, via multicast-enabled core and edge routers. Whilst this resolves the issue of duplicating data transmission by sending the same stream to multiple end-users simultaneously, the content must be sent using specific protocols to enable the multicast routing devices to interact, receive traffic for distribution and prevent routing loops.[36] Although network operators may have some existing equipment capable of delivering multicast services, all the routers in the network would still need to have the functionality enabled and be configured appropriately.[37] This also creates an interoperability challenge, requiring standardisation of protocols across networks that is likely to mean additional cost in terms of both initial set-up and ongoing governance.

Considering the above, multicast is one possible solution for reducing the bandwidth required across the core network for high-quality linear TV broadcasts — though it is not without its challenges. In particular, it does not provide a solution for on-demand functionality, which necessarily requires a point-to-point connection between the content server and end-user as every viewer starts watching at a different time.

In contrast to the multicast model, a deep CDN bypasses the core network by injecting content onto servers connected directly to the handover point ('deep' in the core network), from where it passes straight onto the access network. Whilst a deep CDN delivery model doesn't reduce the total amount of data being sent — as each user still gets their own point-to-point stream when requested — it does remove the need for high bandwidth transmission across the core network avoiding congestion issues without the need for any core or backhaul network upgrades.

Deep CDNs also allow for optimised on-demand services, however, that does mean broadcasters must host their content at every access node in the network, of which there are many (c.1,000). Additional investment is still required to expand these CDNs and ensure there is sufficient coverage to deliver the required content to each edge router in the network. The emergence of virtual CDNs from suppliers such as CISCO has made this easier for operators as it removes the need to invest in their own CDNs, allows them to scale at pace without disadvantaging smaller ISPs. This type of cooperation may also benefit broadcasters, who can share the burden of rolling-out CDNs to distribute their own content.

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36 https://www.juniper.net/documentation/us/en/software/junos/multicast/topics/concept/multicast-ip-overview.html.

37 https://support.biamp.com/General/Networking/Multicast_traffic_and_IGMP.

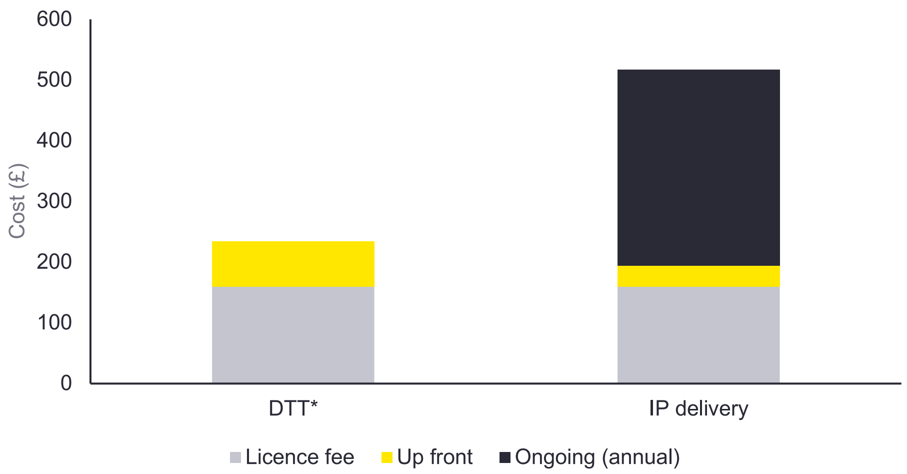
3.2.2 Customer costs

Another consideration for policy makers is how a move to IP distribution would impact on consumers. Both multicast and deep CDN delivery models require customers to have a sufficient broadband connection to take a live TV service. As discussed in Section 2, our analysis finds that by 2035 there will still be c.19% of UK households without a high-speed broadband connection. As such, a move to any IP model introduces a risk of increased inequality, as the higher speed broadband needed to get the expected service quality comes at an incremental cost to consumers. Whilst wealthier households are more able to purchase faster broadband, lower income consumers – or consumers with other vulnerability factors – may be forced into a monthly subscription that they do not otherwise want, averaging £26.90 per month (£322.80 annually) in 2023.[38]

Additionally, customers will need to have the necessary peripheral equipment to access the IP service in addition to the home modem and router. Under a deep CDN model, this would either require a smart TV that supports the relevant applications or an IP device (such as an Amazon Fire Stick) to view the content; whilst for multicast, a separate set-top-box (STB) is required with a wired connection between the broadband and the TV, as multicast is not currently supported over Wi-Fi.

In contrast, DTT users do not pay any ongoing network subscription and only require an aerial to be connected to their TV to enable viewing. The quality delivered to all customers is the same once an aerial is installed, making it an equitable service. Figure 12 presents a stylised comparison of the cost to consumers of both DTT and IPTV, noting that the licence fee must be paid to receive live television whatever method they choose.[39] Furthermore, we note that the total amount currently spent on public services broadcast distribution (~£200mn per annum) represents a small proportion (circa 5%) of the total licence fee income the BBC receives.

Figure 12: Annual and upfront customer costs for accessing TV services



38 https://www.uswitch.com/broadband/studies/broadband-statistics/.

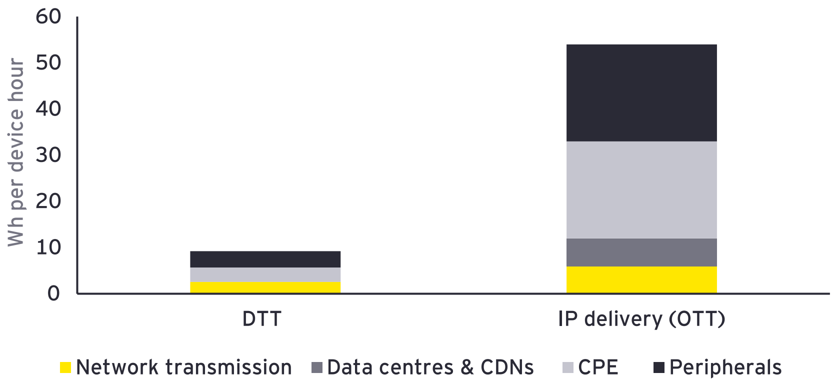
39 With the exception of people in exempt groups, such as the elderly and those with certain disabilities.

3.2.3 Energy efficiency

With the ongoing energy and climate crises, a third key concern for policy makers is the long-term energy efficiency and environmental impact of delivering all live TV over IP networks. In particular, the broadband network would need to be configured to deliver a reliable service at periods of peak demand or risk having quality issues for high-profile TV content (such as live sports events or cultural moments). However, this would be inefficient as the network capacity installed to meet the peak levels of demand would create additional energy requirements, whilst remain under-utilised most of the time.

Environmental, social and governance (ESG) consultancy Carnstone calculates that OTT services over IP networks require six times more energy than DTT services for each viewing hour.[40] The report breaks down the energy usage of each system between data centres and transmission, Customer Premises Equipment (CPE) such as the in-home router, and peripherals (i.e., smart TV devices, or set-top boxes). It finds that for each of these cost groups, energy consumption over broadband is multiple times higher than the DTT equivalent (see Figure 13).

Figure 13: Assumed energy consumption by TV delivery model



40 https://www.ofcom.org.uk/__data/assets/pdf_file/0024/246165/Carbon-emissions-of-streaming-and-digital-terrestrial-television-3.pdf.

3.3 Benefits of a hybrid DTT/IP model

DTT via a rooftop aerial is currently the main way that linear TV is distributed in the UK. The DTT network consists of 1,154 transmitter sites and contains over 3,700 transmitters along with combiners, feeders, antennas, masts, and towers, delivering c.100 free-to-air channels. The Public Service Broadcaster (PSB) network is configured to cover over 98.5% of the UK population, whilst the commercial network covers 90%.

In the DTT network, the channel multiplexer encodes and combines TV content from the broadcaster and sends this across the distribution network to the transmitter sites. At the transmitter site, this signal is sent to the antenna system and broadcast over the airwaves to viewers in the coverage area (with no physical connection from transmitter site to end consumer). Viewers then access the signal through the TV aerial installed on the roof or using a small set-top aerial (see Figure 13).

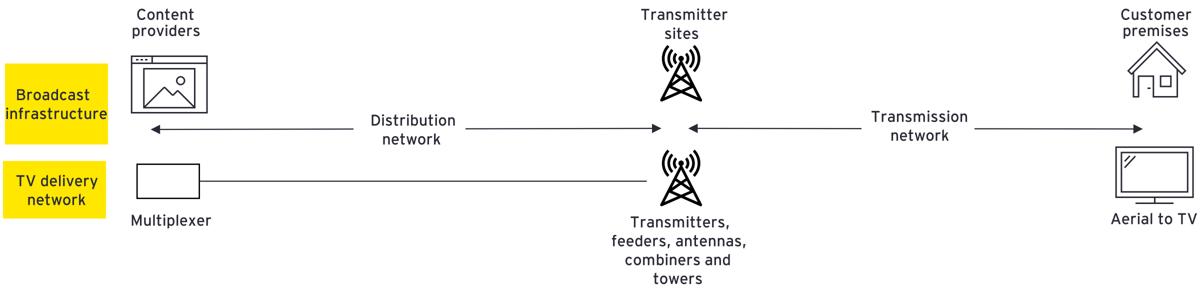


Figure 13: DTT network

Combining this with catch-up and on-demand services over broadband, many consumers are already enjoying a hybrid broadcasting model, with DTT acting as the backbone supplemented by IP services offering increased choice over what and when to watch. These complementary services provide benefits for the three main stakeholder groups in the TV delivery value chain, with each technology bringing additional value whilst addressing the weaknesses of the other:

- **Customers:** a hybrid system offers consumers additional quality and choice, with premium services available over IP for those who wish to pay more. At the same time, the DTT network safeguards the universal provision of PSB services, whilst offering a low-cost and reliable alternative for consumers who want an easy-to-use linear service.
- **ISPs:** for infrastructure providers, a hybrid model lessens the burden on their IP network and helps reduce the excess investment needed to manage peak-capacity. Having DTT pick up a proportion of live TV viewing also helps boost reliability and resilience, preventing many of the quality issues during high demand periods and offering an alternative option in the case of outages.
- **Broadcasters:** a hybrid model also provides greater certainty and protection for broadcasters, with the regulated price for DTT transmission providing a credible competitive alternative in all distribution negotiations. It also limits any risks associated with changes to net neutrality that could otherwise impact on the charges faced for OTT distribution.

We expand on these important considerations around quality and choice, reliability, and certainty for broadcasters further, below.

3.3.1 Quality and choice

Ultimately, consumers are likely to be technology agnostic, with little regard for how their TV is delivered so long as the quality of the service meets their expectations.

One of the main reasons consumers report for adopting IP services is the higher definition streams that can be accessed compared with DTT (e.g., UHD, HDR). Content is provided in multiple different definitions (SD, HD, 4K, etc.), which can be selected by the user via their streaming app or set top box. With investment in deep CDNs, the only constraint to higher definition streaming is the speed of the broadband at the customer premises.

However, video definition is not the only important aspect of broadcast quality, and the IP delivery model can face challenges delivering reliable live TV. For example, packet loss at times when the network is capacity constrained can lead to buffering or content gaps, whilst streaming services. If the access network is capacity constrained either due to requirements on other households connected to the nearest access node or other bandwidth demands in the household, then the quality of the stream can be affected. Where an IP service is streamed over Wi-Fi this further increases the potential for streaming issues as the bandwidth drops significantly compared to a direct ethernet connection. Furthermore, for real-time live broadcasts latency can also be an issue, resulting in delays of 30 seconds or more. This latency is driven by the segment duration, encoding of the adaptive bitrate (ABR) and the buffering required to attempt to ensure continuous video streaming.

In contrast, whilst the DTT network broadcasts a mix of HD and SD channels (the maximum definition for which its sites and multiplexers are currently enabled), it does not face any constraint challenges and the service is unaffected by the number of users watching TV. This is particularly important at times of peak viewing, such as major sporting events or cultural moments.

A hybrid DTT / IP solution offers consumers the best of both worlds – with higher definition services offered on-demand, and reliable HD service for peak-time live-TV. This complementarity may be extended in the future, with potential upgrades to broadcasting sites and multiplexers allowing for further enhancement to the definitions in which DTT can broadcast live TV content.

3.3.2 Reliability

One of the most important considerations for consumers and policy makers when thinking about TV delivery models is the reliability of the network. No matter how good the potential quality of service is, it is of no value to customers if it's not working or regularly drops out.

41 https://www.ofcom.org.uk/__data/assets/pdf_file/0024/246165/Carbon-emissions-of-streaming-and-digital-terrestrial-television-3.pdf.

Indeed, EY's "Decoding the Digital Home" study found that over a quarter of customers experience an unreliable home broadband connection.[41] Ofcom reported that an average of over 70% broadband customers experienced some disconnection in March 2022,[42] and independent research found that 21 million customers (out of a total 28mn) experienced broadband outages of 3 or more hours between summer 2022 and 2023.[43]

21 million
households experienced
a broadband outage of
3 hours or more

A key factor impacting the reliability of a network is the number of potential points of failure. The broadband network contains 4,500 exchanges, c.90,000 street cabinets and over three million telegraph poles, with the majority being part of the access network used to connect to the end consumer. Whilst a migration to full fibre will make broadband networks more robust, there are still vulnerabilities inherent to any IP network. For example, fibre cables are fragile and are especially vulnerable when run above ground (e.g., on poles). Furthermore, Openreach has a set of Quality of Service (QoS) standards which requires it to fix 85% of faults within two working days, and whilst Openreach fix 89% of faults within two working days, this means for c.10% of customers it can take longer to restore service.[44]

In contrast, 90% of the population is served by around 80 DTT transmission sites; and with no physical connection to the end customer, the number of potential points of failure is drastically reduced. This results in a highly reliable service level which has delivered over 99.9% service availability for Arqiva's customers in each of the past five years.

Therefore, a hybrid TV service not only mitigates peak loading concerns – reducing the risk of outages in the first place – it also provides operators with an alternative distribution platform when outages inevitably do occur, allowing them to maintain their service to customers. For consumers, this gives the comfort of having a consistent, reliable TV service supplemented with the option for more advanced services the majority of the time.

3.3.3 Certainty for Broadcasters

A third consideration is the different costs imposed on broadcasters under each system. This is particularly important when it comes to the PSBs, which have a remit to ensure universal access to their PSB content across the UK.

41 https://www.ey.com/en_gl/news/2023/09/ey-study-consumers-are-still-spending-on-digitcal-home-products-and-services-despite-cost-of-living-crisis.

42 https://www.ofcom.org.uk/__data/assets/pdf_file/0015/244140/home-broadband-report-2022.pdf.

43 https://www.uswitch.com/broadband/guides/broadband-outages-uk/.

44 https://www.openreach.com/content/dam/openreach/openreach-dam-files/new-dam-(not-in-use-yet)/documents/regulatory-compliance/Openreach-Q1-23-24-Regulatory-KPIs%20online.pdf.

For DTT, Transmission Services and Network Access (NA) are both regulated, with prices set on a long-term basis using a clear methodology.[45] Transmission Services include the transmission of TV signals from the distribution network on the licensed broadcast frequency through transmitters and where NA provides access to shared broadcast equipment such as masts and towers and antennas. In addition to these regulated charges, the broadcaster incurs the cost of multiplexing and distributing content to the transmission site.

In contrast, the long-term costs to broadcasters under either of the IP delivery models are more complex and uncertain. For multicast, broadcasters must distribute their content to the aggregation nodes (c.10 nationally) at which the core routers are located. In addition to multiplexing costs, network providers may charge broadcasters interconnection and co-location charges to access their network. With deep CDNs, broadcasters must host their content at each handover point in each telecoms network (i.e., around 1,000 nationally, across several different network providers), which can be costly. For example, Netflix has spent over $1bn on local servers in 14,000 locations across 142 countries to build its own 'Open Connect' CDN.[46] Whilst virtual CDNs can be used, prices for these are commercially negotiated, making the long-run access costs uncertain.

A hybrid solution can again provide the best of both worlds. For broadcasters — particularly the PSBs — that require universal coverage, the DTT network provides certainty that there is a long-term, access solution available. At the same time, the regulated DTT prices provide a backstop in negotiation with other distributors — such as virtual CDN operators — helping provide competitive pressure in those unregulated markets.

3.4 Conclusions on TV distribution models

Though consumer habits have been transformed over the last decade by the emergence of many new OTT services and content formats, the market appears to have stabilised with linear TV remaining the most popular form of viewing for UK consumers. For this, consumers and broadcasters are well served by the established DTT network, which provides efficient, reliable, and low-cost TV distribution.

At the same time, consumers are increasingly enjoying higher definition UHD and HDR content from OTT services, at a time and place of their choosing. This is already putting increased pressure on broadband networks, which have had to adopt alternative configuration models to avoid congestion issues impacting on service quality. Both multicast and deep CDNs help solve the challenges relating to transmission in the core network but come at the cost of additional investment for ISPs and increased complexity for consumers.

However, uncertainty remains around how the consumption habits of today's youngest viewers will develop as they age, as well as the scope for technical developments (such as compression technologies and energy efficiencies) that may be cited as solutions to some of the challenges facing IP delivery. This uncertainty calls for a more adaptable approach, that maintains optionality and flexibility in the broadcasting system to ensure meaningful consumer choice into the future.

45 https://www.ota-bts.org.uk/documents/Undertakings%20-%20Non-confidential%20version.pdf.

46 https://openconnect.netflix.com/Open-Connect-Briefing-Paper.pdf.

We find that a hybrid approach combining DTT with a deep-CDN network offers the best of both worlds, with each technology 'filling the gaps' of the other. Whilst IP models can deliver a greater range of content at higher definitions, the DTT network is more reliable, it provides certainty to broadcasters, and it is more energy efficient to operate. Furthermore, the DTT network is the lowest cost network from both an upgrade and customer perspective as it requires only incremental updates to support higher definition services, whilst customers need not pay any ongoing subscription costs for access. Table 5 summarises these considerations, highlighting the keen complementarities between these two technologies.

Table 5: Summary table for different live TV delivery models

Consideration area	DTT	IP-only	Hybrid (DTT+IP)
Upgrade costs	◔	◑	◔
Customer costs	○	◑	◔
Energy efficiency	○	◑	◔
Quality and choice	◑	○	○
Reliability	○	◑	○
Certainty for broadcasters	○	◕	◔

Key:
Worse outcomes ← ● - - ◕ - - ◑ - - ◔ - - ○ → better outcomes

In contrast, the risks involved with switching off the DTT network and moving to an all-IP model are likely to outweigh the benefits. These networks are subject to a higher propensity for outages as well as latency and jitter impacts if they have not been configured appropriately to deal with peak-demand. If all linear TV were transitioned to broadband services this pressure would only grow, compounding the challenges associated with IP delivery. Instead, DTT can continue to provide a backbone for universal TV distribution that can 'take the strain' at times of peak demand, whilst IP services continue to play their role offering consumers an increased choice of content and video qualities.

4. Policy Implications

With policy makers now debating issues that will have a profound impact on the long-term future of TV distribution in the UK, it is crucial that any decisions consider the full effect of any changes across all regions, ages, and social backgrounds.

Our analysis finds that it is unsafe to presume all UK premises will have a sufficiently high-speed broadband to reliably stream live TV by 2035. Whilst the broadband network may have the required coverage by then, a significant number of consumers are likely to be unable or unwilling to take the high-speed broadband subscription needed to watch live-TV via the internet, given the additional costs and complexities this entails. The impact that any reduction to the existing DTT service will have on the most vulnerable groups of society must, therefore, be carefully considered.

In contrast, we observe keen complementarities between the existing DTT network and the evolving IP network – particularly the move toward deep CDNs – with each technology ‘filling the gaps’ of the other to offer consumers meaningful choice over what, when and how they watch. For example, those that wish to pay for a greater range of content and flexibility in their viewing schedule can subscribe to OTT services via broadband to watch high-quality video on-demand; whilst consumers that prefer a low-cost, easy-to-use solution can continue rely on the existing Freeview services delivered over DTT.

However, questions remain as to who pays for the investments needed to establish and maintain these TV distribution networks, impacting on network providers, broadcasters, and consumers. Greater certainty around the future policy environment is needed to help industry secure additional long-term investment into the DTT network, facilitating technical upgrades to unlock improved broadcast quality, as well as the network reconfiguration needed to support increased viewing over IP.

4.1 Ensuring affordable access for all consumers

Our consumer take-up analysis estimates that more than 5.5mn UK premises (18%) will remain without high-speed broadband by 2040, a gap that would need to be filled were all live TV to be migrated to IP distribution. That would mean customers who wouldn't otherwise take high-speed internet having to pay a monthly broadband subscription, as well as the other up-front costs necessary to purchase and install the equipment needed to receive live TV over IP.

At the same time, large sections of the population – including many of today's over 65s – face barriers relating to their confidence and skill in using the internet that is unlikely to change if broadband became the only option for watching TV.[47] For example, DTT is a technology that once installed requires little intervention, whereas broadband requires a greater level of care and maintenance in terms of software updates, hardware replacements, security issues and potential for scams.

A wholesale migration of live-TV to IP distribution is therefore expected to have a particular effect on some of the most vulnerable groups of society, exacerbating inequality as a result of the 'digital divide'. For example, people aged over 75 spend substantially longer than the UK average viewing live TV (almost five hours each day), whilst a body of evidence finds that television viewing is the most common leisure activity in late life and helps alleviate loneliness and social isolation.[48] This highlights the need to ensure vulnerable groups are not inadvertently left behind due to policy changes, such as a complete shift to IP distribution.

This is reflected in the growing support in parliament for securing the long-term future of DTT, echoing calls from their constituents. For example, during a recent debate on the Media Bill, several MPs from across the political divide voiced their support for the continuation of DTT services beyond 2034 and the need to protect the most vulnerable groups in society.

8% of people aged 65-74 and **26%** of people aged 75+ do not have internet access at home

Individuals with disabilities are **2x** as likely to lack the basic digital skills to navigate life online

Up to **2mn** households report affordability issues with their current broadband subscription

> "We risk excluding those who live in rural areas, do not have an internet connection and an older generation that rely on being able to watch television in its traditional format.
>
> Rt hon Stephanie Peacock, MP
> Shadow Minister for Digital, Culture, Media & Sport

47 https://committees.parliament.uk/publications/40662/documents/198365/default/.

48 https://www.researchgate.net/publication/353848795_Television_Viewing_Physical_Activity_and_Loneliness_in_Late_Life.

4.2 Maintaining a choice of quality and service

Undoubtedly, the amount of video content watched over the internet will continue to grow and the UK should continue to invest in these networks. Since 2012, there has been a proliferation of on-demand services from both local broadcasters and new, global services offering a wide range of high-quality content. However, this does not make it appropriate for broadband to be the sole distributor of all TV, as the option of watching via DTT remains an important aspect of consumer choice.

Whilst some consumers may prefer to watch TV over broadband, taking advantage of the additional interactivity and higher definition video quality it offers, this enhanced experience comes at additional cost that other consumers simply don't value or can't afford. Our study finds that a wholesale move to IP distribution would put a significant group of people (over 5.5mn premises in 2040) at risk of being 'left behind' in the digital divide. The on-going subscription costs associated with high-speed broadband, as well as the added complexity of setting up and maintaining the devices needed to watch TV over IP, will mean that some consumers are unable or unwilling to make the switch.

This is particularly true of those with vulnerabilities, such as the elderly, people with physical or mental disabilities, or households on lower incomes. For these groups, meaningful choice does not mean a greater array of higher-definition content; but rather the option to have a reliable, easy-to-use service, that remains free at the point of consumption.

4.3 Investing in TV distribution beyond 2034

The analysis in this report shows that gaps in high-speed broadband adoption will remain even after 2040, which together with an enduring preference for linear TV viewing means DTT is expected to still play an important role for a significant proportion of the population. However, with continued uncertainty around the future of DTT, industry will find it increasingly difficult to attract the investment required to upgrade the network with new technologies (such as UHD) due to the risk of stranded assets and under-recovery of those investments.

In addition, other policy areas, such as net neutrality, also play a role in the future TV debate, to the extent that these impact on the ability of broadband network operators to recover the investments needed to meet the growing bandwidth requirements from increased video traffic. Indeed, ISPs have long argued that they should be able to charge content providers for carrying or prioritising content on their networks,[49] creating additional uncertainty and cost implications for broadcasters and consumers.

49 https://etno.eu/news/all-news/8-news/753-ceo-statement-on-the-role-of-connectivity-in-addressing-current-eu-challenges.html.

The importance of a stable policy environment is also observed in other capital-intensive industries. For example, the European Commission has highlighted certainty as a key enabler for investment in telecoms networks in its 'Recommendation on the regulatory promotion of Gigabit connectivity'.[50] When making any policy decision around the future of TV, it is therefore important to take a long-term view, providing the political certainty needed to ensure the right level of investment can be made to sustain and improve the DTT network for the next generation of TV viewers across the UK.

4.4 Final remarks

Overall, we find that there is considerable ambiguity as to the future take-up of high-speed broadband, as well as the preferences TV viewers will have for where, when, and how they watch TV after 2034.

Whilst we have not conducted a full 'cost-benefit analysis' of the different broadcasting solutions that may be considered, our analysis does find that fixed-broadband is unlikely to provide a universal solution without significant further interventions.

Moreover, we find that the 'downside' risks associated with a wholesale move to IP distribution are spread asymmetrically throughout society, with the greatest costs falling on the most vulnerable whilst the greatest benefits accrue to those able to pay more.

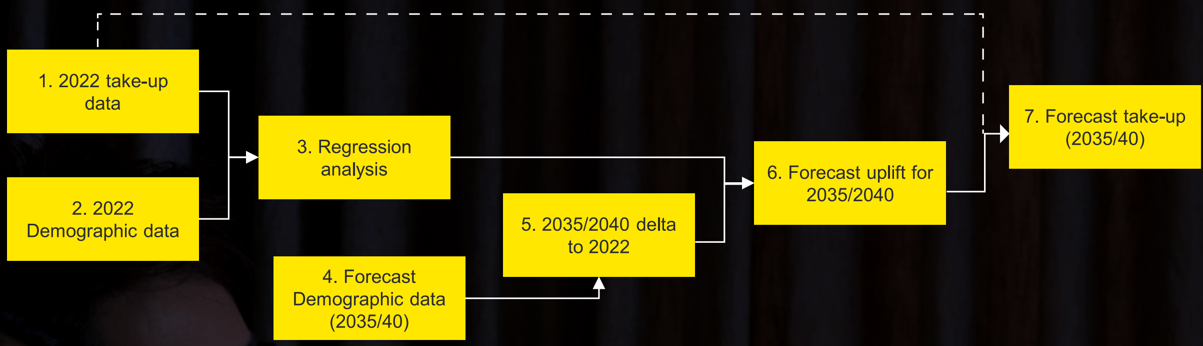
This makes it all the more important that policy makers maintain both optionality and resilience in the broadcasting system, ensuring an on-going universal service that provides every consumer with genuine choice, rather than trading certain costs for uncertain benefits.

50 https://digital-strategy.ec.europa.eu/en/library/gigabit-connectivity-recommendation.

Appendix A
Consumer take-up model

In this section, we outline our methodology for developing the consumer take-up model which forms the basis of our assessment for high-speed internet adoption after 2034. The overall model approach is shown in Figure 14.

Figure 14: Consumer take-up model approach



Using 2022 take-up data and performing regression analysis at the constituency-level, we determine the relationship between different socio-demographic factors and high-speed broadband take-up.

Following that, the same demographic factors are forecast for 2035 and 2040 to generate a delta relative to 2022 for each variable. These deltas are subsequently applied to our regression equation to produce a forecast impact on take-up in both 2035 and 2040. These impacts are applied to the 2022 take-up in each constituency to forecast take-up in both 2035 and 2040. Each of these steps are discussed in more detail below.

Step 1: 2022 take-up data

The first step is to determine the take-up of high-speed broadband. To enable regional analysis at granular level and improve the robustness of our regression analysis, constituency level detail is used.

We obtained a cross-section of UK fixed broadband data, by constituency, from two key Ofcom Connected Nations datasets for 2022:

1. Fixed coverage parliamentary constituency data (fixed coverage dataset)[51]
2. Fixed performance parliamentary constituency data (fixed performance dataset)[52]

51 https://www.ofcom.org.uk/__data/assets/file/0023/249440/202209_fixed_pcon_coverage_r02.zip.
52 https://www.ofcom.org.uk/__data/assets/file/0030/249555/202205_fixed_pcon_performance_r02.zip.

From the fixed coverage dataset (including both residential and commercial premises), we extracted the total number of premises in each constituency, and the number of premises with broadband coverage at each of the following speeds:

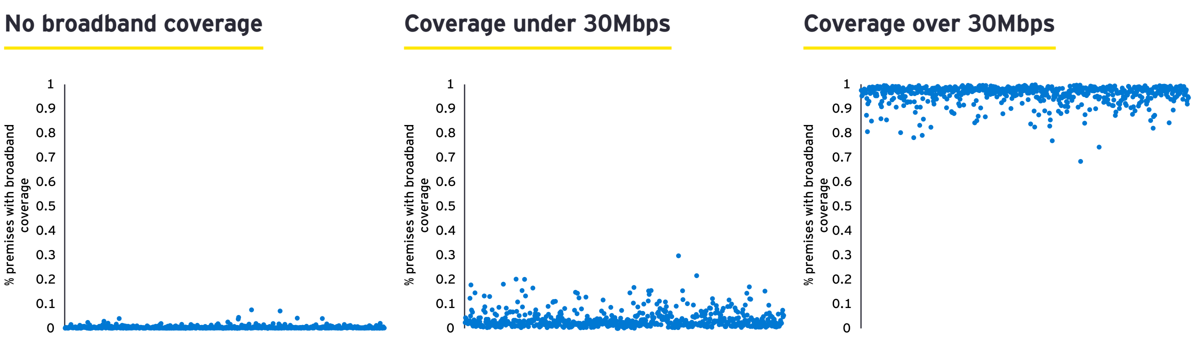
- 0-2 Mbps
- 2-5 Mbps
- 5-10 Mbps
- 10-30 Mbps
- 30-300 Mbps
- Over 300 Mbps

Given the analysis focuses on the adoption of high-speed broadband, the dataset was aggregated into the following three categories:

- No broadband coverage
- Coverage under 30 Mbps only – "Low-speed broadband"
- Coverage equal to or above 30 Mbps – "High-speed broadband"

99.5% of all premises in the UK have broadband coverage, with 96% having high-speed broadband coverage as shown in Figure 15 below.

Figure 15: Broadband coverage by speed, UK 2022



Next, we use the fixed performance dataset to determine the number of active lines / connections at each speed in the same three categories as above. As per Ofcom's methodology document, the performance dataset only includes lines that could be assigned to a geographic postcode level and with a measured speed of greater than zero.[53]

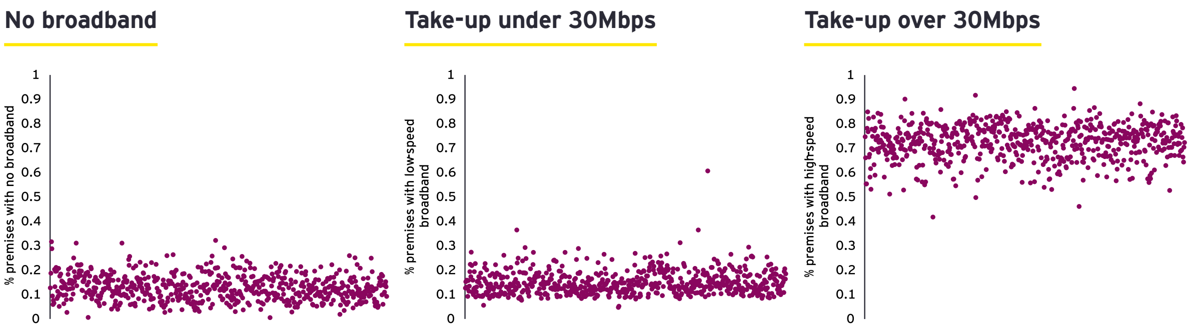
53 https://www.ofcom.org.uk/__data/assets/pdf_file/0031/249286/connected-nations-methodology.pdf.

As a result, the dataset does not capture the total number of lines in the UK, and there are some data gaps where Ofcom could not collect complete information from ISPs. Noting that the fixed performance dataset totals 24.6mn active lines, and Ofcom has confirmed there are 27.7mn fixed broadband lines in the UK as of 2022, we made an adjustment to account for this:

- The total number of lines at each speed in each constituency has been proportionally uplifted by a factor of 1.125 (27.7/24.6) to ensure we do not systematically underestimate the number of fixed broadband connections at the UK level.

We then calculate the take-up for each speed category by dividing the total number of active lines at the respective speed by the total number of premises in the constituency. The findings are as follows:

Figure 16: Fixed broadband take-up by speed, UK 2022



Whilst coverage is almost universal, there remains a significant proportion of the population that choose not to subscribe to high-speed broadband as seen in Figure 16 above.

Table 6: Constituency-level-fixed-broadband coverage and take-up

Below is an excerpt of the coverage and take-up dataset which forms the basis of the quantitative analysis to follow.

Constituency	Total premises	Coverage >30Mbps	Take-up >30Mbps
ABERAVON	33,126	98%	75%
ABERCONWY	30,503	95%	66%
ABERDEEN NORTH	58,136	96%	55%
ABERDEEN SOUTH	53,871	97%	55%
AIRDRIE AND SHOTTS	41,576	97%	78%
ALDERSHOT	48,200	98%	85%
ALDRIDGE-BROWNHILLS	34,230	98%	77%
ALTRINCHAM AND SALE WEST	45,285	97%	82%
ALYN AND DEESIDE	40,766	97%	66%
AMBER VALLEY	44,676	96%	68%

Step 2: 2022 Demographic data

For each of the 650 UK constituencies, demographic data was collected for a range of factors we hypothesised would affect the take-up of broadband. Using the latest available census records,[54] we collected a cross-section of data for the following variables:

1. Age breakdown of the population.
2. Median wage.
3. Proportion of population with disabilities that affect their day-to-day activities.
4. Proportion of working households.
5. Socioeconomic data on jobs, for instance the proportion of population with lower managerial roles, routine tasks, are students or are unemployed or have never worked.

Step 3: Regression analysis

Prior to conducting our quantitative analysis, we assessed the data for robustness, and excluded seven outliers from a total of 650 constituencies. These were identified as anomalies resulting from potential data error, for instance because they had take-up over 100%.

Using the filtered dataset consisting of 643 constituencies, we ran a multivariate Ordinary Least Squares (OLS) regression in R, regressing the take-up of high-speed broadband on all the variables listed above.

Whilst this scoping regression had reasonably high explanatory power (demonstrated by an R-squared statistic of approximately 0.71), not all variables in the regression output were statistically significant. This is likely due to strong correlations between certain variables, for instance a constituency with a higher proportion of full-time students will have a lower proportion of working households.

Upon review of our initial scoping regression, we retained seven demographic variables, alongside three control variables (coverage, proportion of non-residential premises, and variables to capture the nation-based effect). This gives a final regression specification for high-speed broadband take-up of:

High-speed broadband take-up

$$
\begin{aligned}
&= -0.24 + (1.05) \times \mathit{coverage} + (-0.75) \times \mathit{Non\ residential\ premises} \\
&+ (-0.25) \times \mathit{Age26to35} + (0.79) \times \mathit{Age56to65} + (-0.40) \times \mathit{Ageover65} \\
&+ (0.01) \times \mathit{Median\ wage} + (-0.46)\mathit{Disability} + (-0.01) \times \mathit{Scotland} + (0.00) \times \mathit{Wales} \\
&+ (0.01) \times \mathit{NorthernIreland}
\end{aligned}
$$

53 All England and Wales data is sourced from the 2021 census. However, not all data from census 2021 has been released for Scotland as of November 2023, and census data from 2011 has been used wherever required.

The regression specification yields the following output:

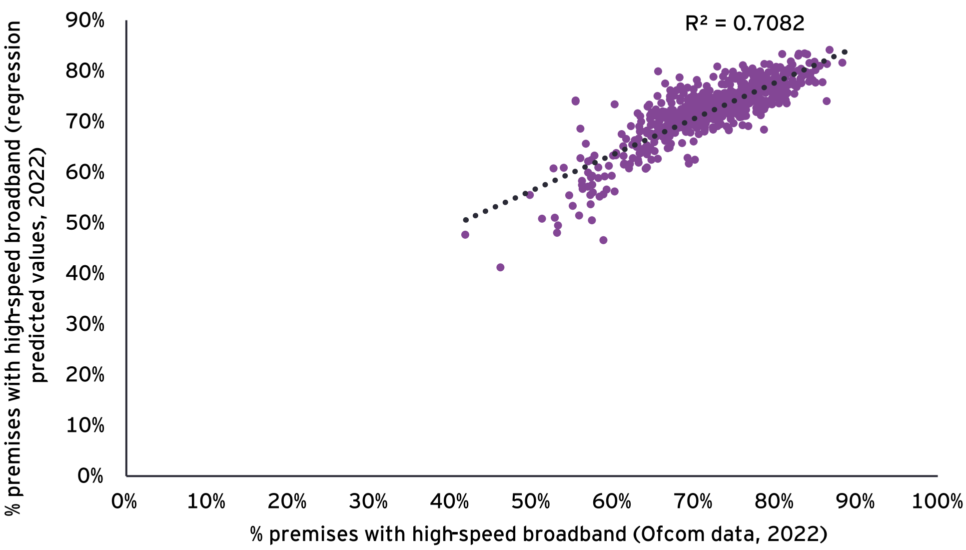
Table 7: Regression outputs

Factor	Coefficient	Significance
Intercept	-0.2430	**
% coverage of high-speed broadband	1.0510	***
% non-residential premises	-0.75	***
% population aged (26 to 35 years)	-0.2524	*
% population aged (56 to 65 years)	0.7982	***
% population aged (over 65 years)	-0.4039	***
% of population reporting disabilities	-0.4647	***
Median wage (as % of UK average median wage)	0.10	***
Control for Scotland	-0.0102	*
Control for Wales	0.00	
Control for Northern Ireland	0.0102	
Multiple R-squared value: 0.7089		
Key: (***) Over 99.9% significant, (*) 99% significance. ( ) Not significant		

The coefficients in Table 7 can be interpreted as the percentage-point change in broadband take-up resulting from a one percentage-point increase in the explanatory factor. For example, a one percentage point increase in the % of premises covered by high-speed broadband is associated with a 1.05 percentage point increase in the take-up of high-speed broadband.

To test the fit of the model, we plotted the predicted take-up values based on the regression coefficients against the actual take-up rate for each constituency, as shown on Figure 17 below.

Figure 17: Fit of the regression model



Step 4: Forecast demographic data (2035/40)
Having established our regression equation for take-up of high-speed broadband, the explanatory variables (i.e., demographic data) need to be forecast for both 2035 and 2040 to feed into our estimation equation for broadband take-up in each of these years. The approach adopted to forecast each of the demographic characteristics is outlined below:

- **Coverage of high-speed broadband:** We have made an overarching assumption that coverage of high-speed broadband in the UK will be universal after 2034. Specifically, we assume high-speed coverage after 2034 is equivalent to total broadband coverage (low and high-speed) in 2022 resulting in a coverage of over 99% in 2035 and 2040 (consistent with government targets). For example, if a constituency has 90% high-speed coverage and 99% total broadband coverage in 2022, we assume high-speed coverage will be 99% in both 2035 and 2040.
- **Proportion of non-residential premises:** We assume no change in the proportion of non-residential premises in each constituency compared to 2022.
- **Age:** We sourced the age distribution for each constituency in the UK from the ONS, along with age-specific mortality rates from Statista. We used the mortality rates to calculate the attrition in each cohort born in a specific year. Assuming constant birth rates, we projected forward the distribution of each age group in every constituency. By forecasting the change in age distribution, we are implicitly assuming that the behaviours of people in each age group do not change over time. For example, people aged between 55-64 today will not adjust their behaviours to match those currently aged 65+ when they are that age in 2035 or 2040. Rather, they will keep their existing preference for broadband usage.
- **Median wage:** Median wages at each constituency are forecast using the 5-year CAGR for the median annual pay for the region of the UK (of which there are 12) to which the constituency belongs. We mapped each constituency to its respective region and applied the annual growth rate minus the long-term inflation forecast (2.0%) to predict the real median wage in 2035 and 2040.
- **Proportion of population with disabilities:** We have assumed the proportion of population with disabilities in 2035 and 2040 will remain consistent with the levels in 2022.
- **Proportion of working households:** The latest available employment rate forecast from the Office of Budgetary Responsibility (OBR) is used to adjust the proportion of working households by the ratio of the forecast rate to the current rate of employment.

Step 5: Calculating 2035/2040 demographic delta to 2022
The forecast demographic data is compared to 2022 and deltas for each variable calculated based on the difference between the forecast year for each constituency. For example, if high speed coverage is expected to increase by two percentage points (e.g., from 97% to 99%) between 2022 and 2035 in a particular constituency, the delta for coverage would be two.

Step 6: Forecast take-up uplift for 2035 and 2040
The demographic deltas forecast for each constituency are applied to the regression equation to produce a take-up uplift as an absolute percentage (one for each of 2035 and 2040).

Step 7: Forecasting take-up in 2035 and 2040
Finally, the take-up uplift is applied to 2022 levels for each constituency to produce both a 2035 and a 2040 high-speed broadband take-up forecast.

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